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United States Department of Agriculture
Agricultural Research Service
Crops Research Division
Beltsville, Maryland

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SUGAR BEET RESEARCH

1958 REPORT[1]

Compiled by Sugar Beet Section

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[1] This is a progress report of cooperative investigations containing data, the interpretation of which may be modified with additional experimentation. Therefore, publication, display, or distribution of any data or statements herein should not be made without prior written approval of the Crops Research Division, A.R.S., U. S. Department of Agriculture, and the cooperating agency or agencies concerned.

CR-4-59

FOREWORD

Sugar Beet Research is compiled annually by the Sugar Beet Section from reports of staff members and cooperators, for the purpose of presenting results of investigations that have been strengthened through contributions from the Beet Sugar Development Foundation. The report also serves to fulfill provisions of research agreements between Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Beet Sugar Development Foundation; the Farmers & Manufacturers Beet Sugar Association; and the Union Sugar Division, Consolidated Foods Corporation.

The areas of investigation to be strengthened by contributions made available through the Beet Sugar Development Foundation have been broadly outlined as projects. In compiling the Report, an effort has been made to group results pertaining to each Foundation Project in a separate Part; but in order to present continuity of subject matter, this aim has not been fully achieved. However, the relevant Foundation project has been indicated on the title page of each Part.

Cooperative field tests conducted by State Agricultural Experiment Stations, the Farmers & Manufacturers Beet Sugar Association, and Agricultural Departments of Sugar Companies, have added greatly to the information concerning variety performances. The cooperation, as it applies, has been indicated under the various Parts of this Report.

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HIGHLIGHTS OF ACCOMPLISHMENTS[1]

New Inbreds, Varieties, and Hybrids.--During 1958, the Sugar Beet Section made available to the Beet Sugar Development Foundation 23 new developments in breeding research for seed increase under provisions of a Memorandum of Understanding. These new developments, differing in seed type, ploidy level, sterility, and disease resistance are described on pages 7 to 12 of this report. The acceptance by the Foundation of the various items for seed increase is given on pages 13 and 14. Some of the proposed items are not being increased through the Foundation, although seed has been supplied to Company members for use in their breeding programs. Small quantities of seed of the items being increased were also supplied to Company members, thereby permitting them to explore the potential use of the items in their breeding programs while seed increases are being made.

Seed productions in 1958 of items made available to the Foundation in 1957 are given on pages 15 and 16. The description of the items proposed for increase in 1957 is given in Sugar Beet Research, 1957 Report, pages 5 to 10.

Company members of the Beet Sugar Development Foundation have made requests to staff members of the Sugar Beet Section for special breeding material and genetic strains thought to be of value in their breeding programs. Using a procedure that has been established for this purpose, Company members received, through the Foundation, 13 genetic strains in 1958.

Breeding and Variety Evaluations in the Intermountain Region.--Inbred CT5 and its diverse sublines stemming from an exceptional plant selected at Jerome, Idaho, in 1952, have considerable potential value in sugar beet improvement. The roots of CT5 are long and free of sprangles, as shown in illustrations on page 32. Some of the sublines have high curly top resistance; others are outstanding in combining ability. The progeny of the 1952 mother plant was highly self-fertile and, surprisingly, showed segregation for Mendelian male sterility. Certain selected sublines are excellent type "O" pollinators. Monogerm lines of CT5 recently have been recovered from hybridizations and backcrosses.

Using sterility gene aa as a means of bringing about hybridizations, excellent hybrids have been obtained with CT5. In a test conducted at Twin Falls, Idaho, in 1956, the F_1 hybrid CT5aa X CT9 gave 17.1 percent more gross sugar per acre than US 41. In a test conducted at Jerome, Idaho, in 1958 (page 20), the hybrid US 22MS X CT5, designated SL 7107, produced 18 percent more gross sugar per acre than US 41; while in a similar test at Taylorsville, Utah (page 23), the yield was 7 percent higher. In both tests, the differences in favor of the hybrid SL 7101 were statistically significant.

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[1] Composed by Dewey Stewart

In light of the use that is being made of cytoplasmic male sterility in the production of hybrid seed and the great value of cytoplasmic and Mendelian male sterility as tools in sugar beet improvement, the aberrant types of male sterility under study by F. V. Owen are of much interest. The probability of a cytoplasmic influence on the expression of Mendelian male sterility and the possibility that cytoplasmic male sterility may simulate Mendelian male sterility in breeding behavior present important problems in relation to the utilization of male sterility in the production of commercial hybrids.

The performances of SL 630 in tests at Salt Lake City, Utah, and at Jerome, Idaho, are of interest. SL 630 is the second backcross from the hybridization of the sugar beet and the fodder beet, Ovana--the sugar beet being the recurrent parent. This hybrid was significantly higher than US 35 in root yield at both locations. It was also higher in sucrose percentage, but the differences were not statistically significant. In both tests, a summary of the chemical determinations by Myron Stout indicated higher purity for SL 630 than for US 35. In the test at Salt Lake City, the amino-nitrogen and sodium were lower in the hybrid than in US 35. From past experience, increased root yield from the hybridization of the sugar beet and the fodder beet is to be expected, but the high sucrose percentage and high quality in SL 630 is unusual for hybrids from this type of parental material.

The variety test conducted by J. C. Overpeck at State College, New Mexico, in cooperation with the New Mexico Agricultural Experiment Station, gave an unusual opportunity to evaluate varieties with respect to leaf spot and curly top. The usual severe epidemic of curly top was experienced in 1958; in addition, there was an epidemic of Cercospora leaf spot. In this test, SP 57109-0 gave the highest root yield in both the early and late planted tests. The breeding history of this variety is given on page 198.

Screening Tests and Breeding for Nematode Resistance.--Screening tests are being continued at the U. S. Agricultural Research Station, Salinas, California, with a wide selection of breeding material. New material is being brought into the program as new seed accessions and as selections from nematode infested fields. Earlier selections are now in their second cycle of breeding. Some of the strains from the second cycle of breeding show improved tolerance to the nematode. One of the lines showing vigor under severe exposure is illustrated in figure 1, page 72. Inoculum from nematode infested fields will contain fungi that cause damping-off, and often the selections are made under exposure to damping-off as well as to the nematode. Some of the selections have shown striking tolerance to the attack of both the sugar beet nematode and the fungi causing damping-off. In figure 2, the outstanding performance of Nema. Sel.859 is shown in comparison with US 41.

In 1958, an extensive field test was conducted by C. H. Smith near Salt Lake City, Utah, on land heavily infested with Heterodera schachtii. There was also severe curly top exposure, which may have greatly influenced the relative performances of the various entries in Groups 2 to 7, reported on pages 77 to 83. However, among the curly-top-resistant

varieties there was a striking difference in the tendency to wilt, which is taken as an indication of the extent to which the plants are suffering from nematode attack. The general vigor of the varieties and their ability to produce root yields were also taken as indicating nematode tolerance. Vigor ratings given in the various tables show that under the conditions of these tests there were striking differences among the varieties in tolerance to the nematode.

Since the monogerm varieties included in the test were for the most part not curly top resistant they were reduced in yield by the disease, and it was very difficult to determine their nematode reaction. Some of the nematode resistant selections made in 1957 (Group 7, page 83) were outstanding in foliage growth and root size. The performances of this group of selections indicate clearly that progress is being made in the development of nematode resistant sugar beets.

Appraisal of Virus Yellows Damage and Breeding for Resistance.--Field experiments have been conducted at Salinas, California, by C. W. Bennett and J. S. McFarlane, to determine the reduction in seed yields when the plants are infected with virus yellows. In the experiment with inbred 6532-29, the inoculations made before seedstalk development caused a reduction in seed yield of 54.2 percent in plots of transplanted plants and 70.2 percent in stands obtained by direct seeding. The marked yellowing of the plants and the reduction in size are illustrated on page 101, figure 2. A test with US 33 showed a reduction in seed yield of 44.6 percent. In an experiment conducted with the annual beet SL 54484-0 in 1956-57, virus yellows inoculation caused a reduction of 44.5 percent in seed yield. In all of these inoculation tests, a virulent strain of the virus was used. Although virus yellows caused a striking reduction in seed yield, there is no evidence from these tests that the disease caused a reduction in percentage germination. From these inoculation tests, it is evident that virus yellows may profoundly influence seed yields. If infection occurs before the sugar beets begin to bolt, reductions of 40 to 50 percent in seed yield yields can be expected. Later infections will result in correspondingly lower reductions in yields.

Progress is being made in screening inbreds and hybrids for yellows tolerance, but the tests have failed to bring to light a high level of resistance among available breeding material. In December plantings, root yields were strikingly reduced by virus yellows inoculations made on March 4. The reduction in root yields of the varieties ranged from 26.2 to 44.0 percent, the reduction in percentage values for sucrose concentration ranged from 0.27 to 0.83 percent, and for inbreds the range in yield reduction was from 26.2 to 55.7 percent.

Varieties that showed least damage from virus yellows in field tests of 1957 tended to perform well in 1958, indicating that the present method of appraising virus yellows damage can be used with some degree of confidence.

The tendency for the natural spread of virus yellows infection in varieties is a character of importance. In an experiment with 8 varieties, the percentage of natural infection ranged from 3.9 to 17.3; in a test with other varieties, the infection ranged from 2.2 to 18.2 percent; and in a third test, the range of natural infection was from 3.4 to 35.3 percent. However, the indicated tendency for some varieties to escape infection might not be experienced in solid plantings. The results obtained in 1958 confirmed those of 1957 in showing that difference in susceptibility to infection is not directly related to the extent of damage that may be caused by the virus after infection has occurred. In US 75, mass selection for resistance did not give significant difference in favor of the selected phase of the variety. It is concluded that either tolerance variability within US 75 is not great or that mass selection is an ineffective method of bringing about improvement in resistance to the disease.

Interspecific Hybrids.--Significant progress has been made by Helen Savitsky in the production of viable F_1 plants from the hybridizations of the cultivated form of beet and the species comprising the section Patellares of the genus Beta. In all of the hybridizations, the female parent was a form of cultivated beet; for example, diploid sugar beet, fodder beet, garden beet, and Swiss chard, as well as tetraploid sugar beet and tetraploid Swiss chard. The pollinator used in each of the hybridizations was a species of the section Patellares; namely, Beta webbiana, B. procumbens, and B. patellaris--the latter being tetraploid and the others, diploid. Through various combinations of sorts from each of these 2 parental groups, diploid, triploid, and tetraploid hybrid progeny were obtained.

From the various hybridizations 85 plants were grown to the flowering stage on their own roots--18 diploids, 5 triploids, and 62 tetraploids. Some of the plants are illustrated on page 51. The hybrid plants flowered abundantly. They were generally pollen sterile, but the tetraploids were semifertile, with as many as 30 seeds being produced on a single plant. In all, 200 hybrid seeds have been obtained. These F_1 seeds have not been germinated.

The hybridization of a tetraploid sugar beet and plants of Beta trigyna ($2n = 36$) is reported by G. E. Coe. Backcross plants were brought to flower in 1958 from this hybridization. There are in culture 262 seedlings from a backcross. Although many of these plants appear to be quite similar to the pollen parent, B. trigyna, others show morphological characteristics indicating a blend of the two parents. Sterility of the F_1 hybrid and the succeeding generations has been overcome to some extent, and the breeding program to develop a new source of germplasm from this hybridization should proceed without difficulty.

Polyploidy in Relation to Curly Top Resistance.--Several varieties of sugar beets have been established on the tetraploid level by Helen Savitsky, and some of these have been compared with their respective parental diploid variety in curly top resistance. These comparisons have been made since 1953 at Jerome, Idaho, with the assistance of A. M. Murphy; and in addition, comparisons were made under curly top exposure

at Salt Lake City, Utah, in 1958. The varieties of interest in this study are US 35/2, US 104, and US 401.

The tetraploid populations of US 35/2 and US 104 were higher in curly top resistance than the diploid parental variety. The difference in curly top readings between the levels of ploidy for each of the comparisons was statistically significant. The comparison between US 401 and its tetraploid counterpart was most striking, as illustrated in figure 2, page 61. The difference in curly top reaction between the two ploidy levels of US 401 is most remarkable, since the variety has not been selected for resistance to this disease. The findings have been interpreted as indicating that in certain diploid varieties of sugar beets, curly top resistance can be improved by the device of autotetraploidy.

Development and Evaluation of Sugar Beets Suitable for California.--Two new hybrid varieties, US H2 and US H3, which were developed in the breeding work of J. S. McFarlane, have been made available for commercial use. In the production of hybrid seed, cytoplasmic male sterility is used to bring about the hybridizations. Both hybrids have good curly top resistance and are moderately good in bolting resistance. The parentage of the hybrids and the record of their performances in evaluation tests in California have been given in Part VI of this report and in Part III of 1957 Report.

Gametocide FW-450.--Results of experiments conducted with the chemical, sodium 2,3-dichloroisobutyrate (FW-450), have been reported by LeRoy Powers (page 150), I. O. Skoyen (page 146), and G. E. Coe (page 188). According to the publication by F. M. Eaton (Science, December 6, 1957), this chemical suppresses pollen production in cotton. These results clearly indicate that the chemical will cause delay in pollen production; however, applications that significantly reduce pollen production are likely to reduce seed yields as well. Additional work must be done with this chemical on sugar beets before a clear statement can be made concerning its potential use in hybrid seed production.

Russian Monogerm Seed.--During the summer of 1958, a group of agricultural workers known as U. S. Agricultural Crops Survey Group visited Russia. C. O. Erlanson, Chief, New Crops Research Branch, was a member of the group. He consented to arrange for an exchange of monogerm sugar beet seed between the United States and Russia. From the contacts he made at the All-Union Institute of Plant Industry, Leningrad, an exchange of seed was agreed upon. Two monogerm varieties have been received from Russia and monogerm seed from this country has been supplied to the All-Union Institute. Seed of the introductions has been distributed as PI 254575 and PI 254576.

Seed of these Russian monogerm varieties has been distributed to members of the staff of the Sugar Beet Section engaged in breeding research and to breeders of company members of the Beet Sugar Development Foundation.

PART I

NEW DEVELOPMENTS IN BREEDING RESEARCH

Inbreds, Hybrids, and Breeder Seed
of Synthetic Varieties

Items Proposed for Seed Increase
June 4, 1958

Distribution and Utilization of Items

Seed Productions of 1957 Items

NEW DEVELOPMENTS IN BREEDING RESEARCH

Items Proposed for Seed Increase
June 4, 1958

The various items proposed for seed increase through the Beet Sugar Development Foundation are grouped according to region of development. The current designation, a brief description, and the estimate of seed available August 1 are given for each item. The inbred lines, breeder seed, synthetic varieties, and other items were developed in breeding research conducted by the staff of the Sugar Beet Section in cooperation with:

Colorado Agricultural Experiment Station
Michigan Agricultural Experiment Station
Minnesota Agricultural Experiment Station
New Mexico Agricultural Experiment Station
Beet Sugar Development Foundation
Farmers & Manufacturers Beet Sugar Association
Union Sugar, Division Consolidated Foods Corp.

I. U. S. Sugar Beet Field Laboratory, Salt Lake City, Utah.

Tetraploid Self-Sterile Multigerm

Item 1. SLC 340 - - - - - - - - - - - - - - - 6 pounds

Item 2. SLC 342 - - - - - - - - - - - - - - - 6 pounds

SLC 340 was used as pollinator with diploid male-sterile monogerm SLC 91 in the production of a triploid hybrid. The triploid was tested by several beet sugar companies in 1957. In some locations it showed high sugar yield. SLC 340 is higher in sucrose than SLC 342. Both are resistant to curly top. These tetraploids were developed by Drs. Helen and V. F. Savitsky.

Multigerm Self-Fertile Lines

Item 3. CT5 aa X CT7 (SL 507+157) - - - - - - - - 1/4 pound
(30% aa Mendelian male-steriles expected)

Suggested use of this curly-top-resistant hybrid: Production of 3-way hybrid (CT5 X CT7) X CT9 by roguing to aa Mendelian male-sterile segregates and utilizing CT9 as the pollinator. The two hybrids, CT5 X CT9 and CT7 X CT9, have been highly productive and probably the best multigerm hybrids yet produced at the Salt Lake City station. It is anticipated that the 3-way hybrid (CT5 X CT7) aa X CT9 may be equally good. This 3-way hybrid should be more economical to produce than a 2-way hybrid. The ultimate utilization would be for pollination of monogerm male-steriles.

Item 4. CT7 (SL 5070+0) - - - - - - - - - - - - - 1/10 pound
(30% aa Mendelian male-steriles expected)

Suggested use of this curly-top-resistant line: Production of sib or backcross population of CT7 which will segregate for 50% Mendelian male sterility.

Monogerm Self-Fertile Lines

Item 5. SLC 127 (formerly line 242) - - - - - - - 100 grams

A curly-top-resistant Type O for the production of 100 percent male sterility, rr hypocotyl.

Item 6. SLC 128 (formerly line 244) - - - - - - - 100 grams

A curly-top-resistant Type O for the production of 100 percent male sterility, RR hypocotyl.

II. U. S. Agricultural Research Station, Salinas, California.

Breeder Seed - Monogerm

Item 7. CT569 - - - - - - - - - - - - - - - - - 3 pounds

This monogerm inbred is the increase of an S_3 line from NB1 X SLC101mm. It has excellent bolting resistance, medium vigor, good seed-setting ability, and moderate curly top resistance. Although it is not Type O, no pollen producers have been observed

in hybrids with male-steriles. Combining ability data are available only from the 1958 Brawley variety test. In this test the performance of hybrids involving C7569 ranged from very good to poor, depending on which male-sterile was used as the female parent.

Item 8. C8569HO - - - - - - - - - - - - - - 3 pounds

This male-sterile represents the first backcross to C7569.

Item 9. C8507rr - - - - - - - - - - - - - - 1 pound

This is a green hypocotyl selection from C7507, a monogerm inbred proposed for increase in 1957. (See Item 10, 1957 Report.) C8507rr should be similar to C7507 in characteristics other than hypocotyl color and could be considered as a replacement.

Item 10. C8507HOrr - - - - - - - - - - - - - - 1/2 pound

This male-sterile represents the third backcross to C8507. It has the green hypocotyl color.

Breeder Seed - Multigerm

Item 11. NB5 - - - - - - - - - - - - - - 5 pounds

This is a Type O bolting-resistant multigerm inbred from US 56/2 X NB1 and has carried the breeder seed number C5547. It has good curly top resistance and excellent vigor. It is one of the parents in the hybrid 663H2, which performed well in all tests in the coastal area in 1957. It is suggested that NB5 be used as the pollen parent with the MS of NB1 to produce the female parent for a hybrid similar to 663H2.

Item 12. MS of NB5 - - - - - - - - - - - - - - 5 pounds

This male-sterile represents the second backcross to NB5 (C5547).

Item 13. NB6 - - - - - - - - - - - - - - 1 pound

This multigerm inbred is the increase of an S_4 line from US 22/3 X NB1 and has carried the breeder seed number C5512. This inbred has extreme bolting resistance and excellent curly top resistance. In tests at Salinas it rarely bolts, even when planted in September. It has medium vigor and produces a satisfactory yield

of seed when planted by early August in Oregon and Tehachapi. The root of this inbred is sprangled. Hybrids in which the MS of NB5 X NB6 has been used as the female parent have shown excellent seedling vigor when planted in the winter.

Item 14. C8503 - - - - - - - - - - - - 1 pound

This multigerm inbred is an increase of an S_5 line from 453 X NB1. This inbred has excellent mildew resistance and showed tolerance to nematode attack in a field test at Salt Lake City in 1957. It has only fair curly top and bolting resistance. Combining ability tests have not been made. This inbred is not recommended for use in commercial hybrids without additional testing. It is made available for use in nematode tests and as a source of mildew resistance. A seed increase would be desirable.

Item 15. C8503HO - - - - - - - - - - - - 1/2 pound

This male-sterile represents the second backcross to C8503.

Item 16. C884 - - - - - - - - - - - - 40 grams

This is the second successive bolting-resistant selection from US 201B. The first selection from US 201B bolted 30 percent at Salinas as compared with 80 percent for US 201B. A bolting test has not been made with C884, but it is anticipated that a marked improvement has been made over the first selection. The 674H2 hybrid with the parentage (MS of NB1 X NB3) X US 201B performed well in two sugar company tests in the north Sacramento Valley in 1957. In these tests it yielded 7 and 18 percent more gross sugar per acre than did the commercial check. The sugar percentage was equal to that of US 56/2.

III. Breeding for Improvement in Leaf Spot and Black Root Resistance:

Plant Industry Station, Beltsville, Maryland
Michigan Agricultural Experiment Station,
East Lansing, Michigan
Minnesota Agricultural Experiment Station,
Southern Substation, Waseca, Minnesota
Colorado Agricultural Experiment Station,
Fort Collins, Colorado

of seed [illegible] planted by early August in Oregon and Tehachapi. The root of this inbred is [illegible]. Hybrids in which the MS of WB5 x 4P6 has been used as the female parent have shown excellent seedling vigor when planted in the [illegible].

4. 08502 - - - - - - - - - - - - 1 pound

This multigerm inbred is an S₁ line of [illegible] line from 4533 [illegible]. This inbred has excellent mildew resistance and showed tolerance to [illegible] attack in a field test [illegible] in 1957. It has only fair curly top and bolting resistance. Combining ability tests [illegible] not been made. This [illegible] is not recommended for use in commercial hybrids without additional testing. It is made available for use in mildew tests and as a source of mildew resistance. A seed increase would be desirable.

5. 085930 - - - - - - - - - - - - - 1/2

This male-sterile represents the second backcross to 08502.

6. 0604 - - - - - - - - - - - - 40 grams

This is the second successive bolting-resistant selection from US 201. The first selection from US 201 bolted 20 percent at Salinas as compared with 60 percent for US 201. A bolting test has not been made with 0604, but it is anticipated that a marked improvement has been made over the first selection. The 0604 hybrid with the parentage (MS of NB1 x NB3) x US 201 performed well in two [illegible] company tests in the north [illegible] Valley in 1957. In these tests [illegible] yielded 7 and 18 percent more [illegible] sugar per acre than did the commercial check. The sugar percentage was equal to that of US 56/2.

[illegible] for Improvement in Leaf Spot and [illegible] Resistance

[illegible] Industry Station, Beltsville, Maryland
[illegible] Agricultural Experiment Station,
East Lansing, Michigan
[illegible] Agricultural Experiment Station,
Southern [illegible] Substation, Waseca, Minnesota
Colorado Agricultural Experiment Station,
[illegible]
Colorado

Monogerm Synthetic Varieties

Item 17. SP 5831-0 - - - - - - - - - - - - - - 100 pounds

This production is from the interpollination of several progenies derived from monogerm segregants obtained in a program of hybridizations and selections for improvement in resistance to leaf spot and black root.

Item 18. SP 5832-0 - - - - - - - - - - - - - - 40 pounds

A greenhouse production of the same parental composition as SP 5834-0. The seed of SP 5832-0 has been distributed for field tests in Colorado, Michigan, Ohio, Minnesota, Iowa, and Maryland.

Item 19. SP 5834-0 - - - - - - - - - - - - - - 100 pounds

This seed production is from the interpollination of 8 monogerm progenies that were equal to US 400 in yield and in leaf spot resistance, as indicated by results from a late test conducted on the Plant Industry Station in 1957. Information from field tests under way with SP 5832-0 will be important in formulating a statement concerning the advisability of planting SP 5834-0 for commercial seed production.

Item 20. SP 5835-0 - - - - - - - - - - - - - - 25 pounds

This production is an increase of SP 5735-0, which was obtained by the interpollination of 4 monogerm clones. The polycross progenies of the 4 clones were as good as US 400 in field tests conducted under leaf spot and black root exposure.

Item 21. SP 5836-0 - - - - - - - - - - - - - - 125 pounds

This production is from the interpollination of several monogerm progenies arising in the same breeding program as SP 5834-0. However, roots of the choice progenies were used in the production of SP 5834-0. If SP 5832-0 looks promising in the test under way, then synthetic variety SP 5836-0 may be considered for commercial planting.

General Statements Concerning Items 17 through 21:--Although these synthetic varieties have been derived from the most promising monogerm material obtained in a program of hybridizing, selecting, and testing at the Plant Industry Station, we are not in a position at this time to make definite recommendations for their use in extensive

plantings for commercial production. The plantings of SP 5832-0 are under close study and should supply valuable information on seedling vigor, foliage vigor, and disease resistance, before August 1. Prior to planting time for overwintering seed crops, the information at hand concerning these synthetic varieties will be made available to those interested in the production of seed in excess of experimental quantities.

Seed productions of Items 17, 18, 19, 20, and 21 have been augmented through a special contribution from the Farmers & Manufacturers Beet Sugar Association as an addition to Foundation Project 26.

IV. Breeding for Leaf Spot and Curly Top Resistance:

Plant Industry Station, Beltsville, Maryland
U. S. Sugar Beet Field Laboratories
Salt Lake City, Utah, and Twin Falls, Idaho
New Mexico Agricultural Experiment Station,
State College, New Mexico

Multigerm

Item 22. SP 581-0 - - - - - - - - - - - - - - 1 pound

This is a production from selections made by Professor Overpeck under curly top exposure at State College, New Mexico. The selections were made from 6 strains that are resistant to leaf spot and curly top.

Item 23. SP 586-0 - - - - - - - - - - - - - - 1 pound

Seed production from plants of SP 561-0 surviving curly top exposure at Jerome, Idaho. Selections were made by A. M. Murphy.

Items 22 and 23 are multigerm but may be of interest as pollinators carrying resistance to leaf spot and curly top.

From: James H. Fischer, Secretary, Beet Sugar Development Foundation
August 15, 1958

UTILIZATION OF USDA SEED RELEASES, 1958

ITEMS LISTED CORRESPOND TO THOSE LISTED IN THE RELEASE MEMORANDUM-[1]

I. U. S. SUGAR BEET FIELD LABORATORY, SALT LAKE CITY, UTAH

ITEM 1. SLC 340 - WILL NOT BE INCREASED, BUT THE AVAILABLE QUANTITY WILL BE UTILIZED AS FOLLOWS: ONE POUND, HOLLY SUGAR CORPORATION; ONE-HALF POUND, AMERICAN CRYSTAL SUGAR COMPANY; ONE-FOURTH POUND, SPRECKELS SUGAR COMPANY; ONE POUND, UTAH-IDAHO SUGAR COMPANY; ONE POUND, AMALGAMATED SUGAR COMPANY; ONE-HALF POUND, UNION SUGAR DIVISION; ONE-HALF POUND, CANADIAN SUGAR FACTORIES LIMITED; 25 GRAMS, GREAT WESTERN SUGAR COMPANY.

ITEM 2. SLC 342 - WILL NOT BE INCREASED, BUT MAY BE REQUESTED BY COMPANIES SIMILAR TO ITEM 1.

ITEM 3. CT5 AA x (SL 507+157) - WILL BE INCREASED BY THE UTAH-IDAHO SUGAR COMPANY AND AMALGAMATED SUGAR COMPANY.

ITEM 4. CT7 (SL 5070+0) - SAME DISTRIBUTION AND UTILIZATION AS FOR ITEM 3.

ITEM 5. SLC 127 (FORMERLY LINE 242) - AN INCREASE OF THIS NUMBER WILL BE MADE BY THE UTAH-IDAHO SUGAR COMPANY AND AMALGAMATED SUGAR COMPANY. REASONABLE AMOUNTS OF THE INCREASE WILL BE MADE AVAILABLE TO COMPANIES OTHER THAN THOSE MAKING THE INCREASE.

ITEM 6. SLC 128 (FORMERLY LINE 244) - WILL BE INCREASED AND DISTRIBUTED EXACTLY AS INDICATED FOR ITEM 5.

II. U. S. AGRICULTURAL RESEARCH STATION, SALINAS, CALIFORNIA

ITEM 7. C7569 - WILL BE INCREASED BY THE WEST COAST BEET SEED COMPANY IN A ONE-ACRE PLANTING IN COMBINATION WITH F58-515HO AND C8569HO. SEED FROM C7569 AND C8569HO WILL BE DISTRIBUTED AS A FOUR-WAY SPLIT AMONG THE CALIFORNIA PROCESSORS. SEED FROM F58-515HO WILL BE DISTRIBUTED APPROXIMATELY AS FOLLOWS: HOLLY - 10%; SPRECKELS - 5%; UNION - 85%.

ITEM 8. C8569HO - SEE ITEM 7 INVOLVING THIS NUMBER IN COMBINATION WITH OTHERS.

ITEM 9. C8507RR - APPROXIMATELY A ONE-FOURTH TO ONE-HALF ACRE INCREASE WILL BE MADE BY THE WEST COAST BEET SEED COMPANY IN COMBINATION WITH F58-515HO AND C8569HO. A FOUR-WAY SPLIT OF THE SEED PRODUCED WILL BE MADE AMONG THE CALIFORNIA PROCESSORS.

1/ ANNOUNCED FOR RELEASE PER MEMORANDUM FROM THE TOBACCO AND SUGAR CROPS RESEARCH BRANCH DATED JUNE 4, 1958 FROM DEWEY STEWART, HEAD, SUGAR BEET SECTION.

ITEM 10. C8507RR - SEE ITEM 9 INVOLVING THIS NUMBER IN COMBINATION WITH OTHERS.

ITEM 11. NB5 - A ONE-ACRE INCREASE OF THIS IN COMBINATION WITH MS OF NB1 (MS OF NB1 FROM PARTICIPANTS IN INCREASE OR IF NOT OKAY FROM UNION WILL BE MADE BY THE WEST COAST BEET SEED COMPANY. THE INCREASE WILL BE SHARED AS FOLLOWS: HOLLY - 25 POUNDS; SPRECKELS - 25%; UNION - 75%.

ITEM 12. MS OF NB5 - A FOUR-ROW STRIP OF THIS IN COMBINATION WITH NB5 (SEE ITEM 11) WILL BE PLANTED BY THE WEST COAST BEET SEED COMPANY. THE RESULTING SEED WILL BESHARED IN A THREE-WAY SPLIT BY HOLLY, SPRECKELS, AND UNION.

ITEM 13. NB6 - APPROXIMATELY 0.1 ACRE INCREASE OF THIS IN COMBINATION WITH MS OF NB5 (SEE ITEM 12) WILL BE MADE BY THE WEST COAST BEET SEED COMPANY. THE INCREASE WILL BESHARED AS FOLLOWS: HOLLY - 20% OR 25 POUNDS; SPRECKELS - 40% OR 50 POUNDS; UNION - 40% OR 50 POUNDS.

ITEM 14. C8503 - NO INCREASE, THE AVAILABLE QUANTITY WILL BE UTILIZED IN PART BY THE SUGAR COMPANIES AS FOLLOWS: HOLLY - 25 GRAMS; AMERICAN CRYSTAL - 25 GRAMS; GREAT WESTERN - 25 GRAMS; SPRECKELS SUGAR - 25 GRAMS.

ITEM 15. C8503HO - NO INCREASE, THE AVAILABLE QUANTITY WILL BE UTILIZED BY THE SAME COMPANIES AND IDENTICAL AMOUNTS AS NOTED FOR ITEM 14.

ITEM 16. C884 - NO INCREASE, THE AVAILABLE QUANTITY WILL BE UTILIZED IN PART AS FOLLOWS: HOLLY - 5 GRAMS; GREAT WESTERN - 5 GRAMS.

III. BREEDING FOR IMPROVEMENTS IN LEAF SPOT AND BLACK ROOT RESISTANCE.

ITEM 17. SP 5831-0 - WILL BE INCREASED BY THE WEST COAST BEET SEED COMPANY FOR THE FOLLOWING COMPANIES IN THE ACREAGE AMOUNTS AS SHOWN: FARMERS AND MANUFACTURERS, ONE ACRE; HOLLY, ONE-HALF ACRE; GREAT WESTERN, ONE-HALF ACRE; AMERICAN CRYSTAL, ONE-HALF ACRE.

ITEM 18. SP 5832-0 - APPROXIMATELY A TWO AND ONE-HALF ACRE INCREASE WILL BE MADE BY THE WEST COAST BEET SEED COMPANY FOR THE SAME COMPANIES AND THE SAME AMOUNT FOR EACH AS INDICATED IN ITEM 17.

ITEM 19. SP 5834-0 - NO ADDITIONAL INCREASE HAS BEEN REQUESTED. THE AVAILABLE QUANTITY WILL BE DRAWN UPON BY COMPANIES UPON REQUEST.

ITEM 20. SP 5835-0 - NO ADDITIONAL INCREASE HAS BEEN REQUESTED. THE AVAILABLE QUANTITY WILL BE UTILIZED AS INDICATED FOR ITEM 19.

ITEM 21. SP 5836-0 - NO ADDITIONAL INCREASE HAS BEEN REQUESTED. THE AVAILABLE QUANTITY WILL BE UTILIZED AS INDICATED FOR ITEMS 19 AND 20.

IV. BREEDING FOR LEAF SPOT AND CURLY TOP RESISTANCE.

ITEM 22. SP 581-0 - THE FOLLOWING COMPANIES REQUEST IMMEDIATE QUANTITIES AS FOLLOWS: AMERICAN CRYSTAL - 25 GRAMS; GREAT WESTERN - 25 GRAMS; HOLLY - 25 GRAMS; SPRECKELS - 25 GRAMS. THE BALANCE OF THE SEED IS TO BE SENT TO THE UTAH-IDAHO SUGAR COMPANY FOR INCREASE.

ITEM 23. SP 586-0 - THE SAME COMPANIES AS LISTED FOR ITEM 22 WILL WISH THE SAME QUANTITIES OF THIS SEED NOW. THE UTAH-IDAHO SUGAR COMPANY WILL INCREASE THE BALANCE OF THE SEED.

1958 Seed Productions of 1957 Proposals for Seed Increase

(see 1957 Report, pp. 5-13)

1957 Proposals		1958 Productions	
Item	Strain	Producer and Designation	Am't. (lbs.)
1	CT5 (Line 157)	Utah-Idaho Sugar Co.	40.0
2	SLC 34	Utah-Idaho Sugar Co.	13.5
3	SLC 35	Not increased	0
4	SLC 35MS mm	Not increased	0
5	SLC 36-0(aaBC)	Utah-Idaho Sugar Co.	45.5
6	SLC 123	Utah-Idaho Sugar Co.	25.5
7	SLC 124	Utah-Idaho Sugar Co. West Coast Beet Seed Co.; Lot No. 8307	5.5 92.0
8	SLC 125(aaBC)	Not increased	0
9	SLC 125MS mm	Not increased	0
10	C7507	West Coast Beet Seed Co.; F58-507	1.3
11	C7507HO x C7507	West Coast Beet Seed Co.; Lot No. 8340 (also F58-507HO)	4.0
12	C7515	West Coast Beet Seed Co.; Lot No. 8341 (also F58-515)	14.0
13	C7515HO x C7515	West Coast Beet Seed Co.; Lot No. 8342 (also F58-515HO)	10.0
13a	C7515H1 x C7515	West Coast Beet Seed Co.; Lot No. 8343	12.0
14	C7507H1	West Coast Beet Seed Co.; Harvested by McFarlane	?
15	C7508	No report	
16	C7508HO	No report	

1957 Proposals		1958 Productions	
Item	Strain	Producer and Designation	Am't. (lbs.)
17	C787	West Coast Beet Seed Co.; Lot No. 8201 (also F58-87)	2514
		Utah-Idaho Sugar Co.	3.0
18	SP 5713-0	West Coast Beet Seed Co.; Lot No. 8306	101
		Utah-Idaho Sugar Co.	18.0
19	SP 5714-0	West Coast Beet Seed Co.; Lot No. 8220	8332
		Utah-Idaho Sugar Co.	10.5
20	SP 5716-0	West Coast Beet Seed Co.; Lot No. 8308	115
		Utah-Idaho Sugar Co.	5.0
21	SP 571850-00	West Coast Beet Seed Co.; Lot No. 8309	109
		Utah-Idaho Sugar Co.	7.0
22	SP 5733-0	West Coast Beet Seed Co.; Lot No. 8310	117
23	SP 5734-0	Not increased	
24	SP 571-0	Utah-Idaho Sugar Co.	55.0
25	SP 57102-0	Utah-Idaho Sugar Co.	146
Extra	C7547	Union Sugar Division; F58-547	7.5
Extra	C5502H1 x C7547	Union Sugar Division; F58-547H1	32.0

PART II

DEVELOPMENT AND EVALUATION OF INBRED LINES AND HYBRID VARIETIES OF SUGAR BEETS

with emphasis on

Curly Top Resistance

Monogermness and High Quality

Foundation Projects 22, 23, and 15

F. V. Owen
A. M. Murphy
Charles Price
G. K. Ryser
C. H. Smith
Myron Stout
J. C. Overpeck
and
Cooperators

DEVELOPMENT AND EVALUATION OF INBRED LINES AND HYBRIDS RESISTANT TO CURLY TOP

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PROJECT 22 -- REPORT OF 1958 RESULTS
JEROME TEST FIELD FOR CURLY-TOP RESISTANCE, JEROME, IDAHO

By Albert M. Murphy

As the 1958 season progressed interest also progressed in the Jerome test field, chiefly because of the occurrence and severity of curly top in areas normally little affected by the disease. Injury to the 1958 commercial crop in some areas emphasized the urgency of having multiple resistance in sugar beet varieties in order to avoid catastrophes when a disease exceeds its former bounds.

In the Jerome test field there was an interesting example of how hybrid vigor may complement the inherent degree of curly-top resistance. Hybrids produced in cooperation with the Amalgamated Sugar Company with one-fourth of their parentage from a susceptible variety (Deming's 52-644) made an impressive growth and showed more apparent curly-top resistance than the inbred parental lines which supplied most of the inherent resistance.

Another example of what can be accomplished by vigorous hybrids was the second generation backcross to the curly-top susceptible fodder beet Ovana. This hybrid showed high curly-top resistance, very high tonnage, high sugar percentage, high purity and outstanding total sugar production. Examples of other good hybrids were those made with the inbred CT5 and monogerm derivatives of CT5. The monogerm hybrid, SLC 117 MS mm X the CTR-LSR variety SP 5651-0 (produced by the Utah-Idaho Sugar Co.) performed well in the Jerome test and in several other tests, including the test under a heavy nematode exposure at Salt Lake City and in the test at Las Cruces, New Mexico, which was under heavy exposure to both curly-top and Cercospora leaf spot. Production of better hybrids combining resistance to two or more major diseases is a challenge to all engaged in the breeding work.

As in past years, many varieties furnished by member companies of the Beet Sugar Development Foundation were included in the Jerome test field. These results have been supplied to the member companies. Data included in this report deal with the performance of varieties in replicated tests.

VARIETY TEST, JEROME, IDAHO, 1958

(6 replicated plots of each variety) TEST 4

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD GROSS SUGAR % BASIS	ACRE YIELD TONS BEETS	PERCENT SUCROSE	PERCENT CURLY TOP AUG. 1
7101	US 22 MS X CT5	11,122	118	30.8	18.1	2.3
F54-4H7	CT9 hyb. MS X Klein E Hyb.	10,424	110	29.4	17.7	7.1
7339	117 MS mm X SP 5651-0	10,147	108	29.0	17.6	10.6
7105	US 22 MS X CT5 mm	9,852	104	27.4	18.0	6.4
7107	do. X 644 mm	9,806	104	28.1	17.5	3.9
7326	aa mm X (US 35 aa X 52-644)	9,466	100	26.6	18.1	11.6
028	US 41	9,427	100	26.0	18.1	5.0
7325	aa mm X U-I 110 (SL 202 sel.)	9,365	99	25.9	18.1	11.3
7337	U-I E-110 Commercial mm hyb.	9,308	99	27.0	17.2	10.3
7209	122 aa mm X SLC 125 mm	9,229	98	25.4	18.2	11.3
7106	US 22 MS X SLC 125 mm	9,081	96	27.0	16.8	5.2
7123	229 MS mm X do.	8,862	94	25.2	17.6	9.4
7124	377 MS mm X do.	8,818	93	25.3	17.4	10.7
7338	117 MS mm X SP 554-0	8,621	91	25.0	17.2	14.2
7213	122 aa mm X Sugar sels. mm	8,588	91	24.0	17.9	9.1
7211	6203 aa mm X SLC 126 mm	8,539	91	24.4	17.5	12.8
7203	do. X 644 mm	8,327	88	23.2	17.9	7.1
7263	do. X SLC 122 mm	8,016	85	23.0	17.4	15.3
7276	6205 aa mm X 6207 mm	7,995	85	21.9	18.3	16.7
7127	6129 MS mm X SLC 122 mm	7,022	74	19.4	18.2	22.8
General MEAN of all varieties		9,101		25.7	17.73	
S. E. of MEAN		376		1.05	0.22	
Sig. Diff. (19:1)		1058		2.95	0.61	
S. E. of MEAN in % of MEAN		4.13		4.08	1.24	

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross sugar	MEAN SQUARES Tons beets	MEAN SQUARES Percent sucrose
Between varieties	19	5,251,437	43.33	0.97
Between replications	5	4,776,930	44.20	1.59
Remainder (Error)	95	848,802	6.58	0.28
Total	119			
Calculated F values		6.19**	6.59**	3.46**

* Exceeds 5% point of significance (F = 1.69)
** Exceeds 1% point of significance (F = 2.09)

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

By C. H. Smith

GROWER: Rell Swensen

SOIL TYPE: Welby fine sandy loam

PREVIOUS CROPS: 1952, grain to alfalfa; 1953 to 1956 inclusive, alfalfa; 1957, grain.

FERTILIZERS AND CULTURAL PRACTICES: Applications of manure and commercial fertilizers were used in conjunction with previous crop rotation. In 1958 about 15 spreader loads of chicken litter and 200 pounds of ammoniated phosphate (20-40) per acre were applied and worked into the soil during seedbed preparation.

SOIL FUMIGATION: The soil was fumigated with Dow Telone at 20 gallons per acre in October by the plow method.

PLANTED: April 18.

THINNED: Thinning machine, May 12; Hand thinning, May 16.

IRRIGATIONS: First irrigation June 13. Total of eleven irrigations by furrow.

CURLY TOP: Heavy migrations of beet leafhoppers entered the field about June 1. By June 4 as many as three to four leafhoppers per plant were noted. June 4 they were sprayed with Parathion, one pint per acre. Susceptible varieties developed severe symptoms of curly top.

HARVESTED: October 3, 1958. At harvest the tops were removed with a roto-beater and beets scalped with tractor-mounted scalping tool supplemented by long-handled hoe work. Beets were counted before pulling. Two ten-beet samples were taken from each plot at random for sugar analysis. These samples were weighed after washing to ascertain true tare percentage.

EXPERIMENTAL DESIGN: The variety tests considered here were of randomized block design. The beets were planted in 2-row plots with 20 inches between rows. Objective at thinning was 8 to 10 inches except in spacing test. Four-foot alleys were cut between plots. Effective plot length was 22 feet.

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

(6 replicated plots of each variety   TEST 4

S.L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	ACRE YIELD GROSS SUGAR % BASIS	TONS BEETS	PERCENT SUCROSE	HARVEST COUNT 100'
7101	US 22 MS X CT5	9,158	107	35.7	12.77	109
7105	do. X CT5 mm	8,884	104	32.2	13.80	105
7340	E 799 (ASA2HO X 6-308 mm) (Amalgamated Sugar Co.)	8,804	103	29.1	14.84	95
7325	aa mm X U-I 110 (Utah-Idaho Sugar Co.)	8,744	102	32.4	13.60	103
028	US 41	8,572	100	31.9	13.44	109
7125	244 MS mm X CT5 mm	8,469	99	32.4	14.32	103
7124	377 MS mm X SLC 125 mm	8,386	98	33.9	12.44	102
7337	E-110 Commercial mm hyb. (Utah-Idaho Sugar Co.)	8,195	96	30.5	13.40	106
7123	229 MS mm X SLC 125 mm	8,182	95	33.5	12.17	97
7326	aa mm X (US 35 aa X 52-644) (Amalgamated Sugar Co.)	8,108	94	28.4	13.84	100
7106	US 22 MS X SLC 125 mm	8,016	93	32.2	12.29	110
7127	SLC 122 MS mm	7,946	93	28.0	14.23	100
7126	SLC 126 MS mm	7,815	91	28.4	13.84	97
7107	US 22 MS X 644 mm	7,332	85	30.9	11.87	111
General MEAN of all varieties		8,329		31.1	13.37	
S. E. of MEAN		371		1.35	0.24	
Sig. Diff. (19:1)		NS		3.80	0.67	
S. E. of MEAN in % of MEAN		4.45		4.34	1.80	

VARIANCE TABLE

Variation due to	Degrees of freedom	Gross sugar	MEAN SQUARES Tons beets	MEAN SQUARES Percent sucrose
Between varieties	13	1,414,687	32.38	5.10
Between replications	5	1,722,761	37.22	3.12
Remainder (Error)	64	824,222	10.91	.340
Total	82			
Calculated F values		NS	2.97**	15.02**

* Exceeds 5% point of significance (F = 1.88)
** Exceeds 1% point of significance (F = 2.41)

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

(5 replicated plots of each variety) TEST 5

S. L. NUMBER	DESCRIPTION	ACRE YIELD GROSS SUGAR POUNDS	% BASIS	TONS BEETS	PERCENT SUCROSE
028	US 41	8,606	100	33.2	13.1
	Monogerm aa mm X mm				
7263	6203 aa X SLC 122	8,315	96	30.2	14.0
7213	SLC 122 aa X Sugar sels.	8,242	96	30.2	13.9
7203	6203 aa X Line 644	7,935	92	30.6	13.1
7211	6203 aa X SLC 126	7,783	90	29.4	13.6
7209	SLC 122 aa X SLC 125	7,613	89	30.2	13.0
7276	6205 aa X 6207	6,503	75	25.0	13.5
General MEAN of all varieties		7,857	29.80	13.5	
S. E. of MEAN		337	1.51	0.20	
Sig. Diff. (19:1)		968	3.21	0.57	
S. E. of MEAN in % of MEAN		4.29	5.07	1.48	

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross sugar	Tons beets	Percent sucrose
Between varieties	6	2,352,308	29.91	0.802
Between replications	4	3,392,735	51.73	1.233
Remainder (Error)	24	682,582	10.54	0.196
Total	34			
Calculated F values		3.45**	2.84*	4.09**

* Exceeds 5% point of significance (F = 2.38)
** Exceeds 1% point of significance (F = 3.38)

MONOGERM (aa mm) X MULTIGERM HYBRIDS, TAYLORSVILLE, UTAH
In Cooperation with the Utah-Idaho Sugar Co. and the Amalgamated Sugar Co.
(3 replications)

S.L. NUMBER	FEMALE PARENTAL LINE NUMBER (aa mm)	GROSS SUGAR PER ACRE		BEETS PER ACRE		PERCENT SUCROSE
		POUNDS	% BASIS	TONS	% BASIS	
	U-I 110 as pollinator at St. George, Utah					
72011	1	10,355	104	36.8	100	12.4
72021	2	10,240	102	35.6	99	12.6
72041	4	10,675	107	36.0	100	13.3
72051	5	9,520	95	28.8	83	14.7
72061	6	10,915	109	35.1	101	13.5
72071	7	9,227	92	27.6	86	14.6
72081	8	10,800	108	34.3	107	13.7
72091	9	9,667	97	32.6	102	13.2
72101	10	9,053	91	31.4	99	12.7
72141	14	10,100	101	37.2	116	12.5
72151	15	7,787	78	29.8	88	11.6
72161	16	7,507	75	25.4	75	13.2
72191	19	9,880	99	40.3	120	11.0
72211	21	8,390	84	26.5	75	14.2
72231	23	9,995	100	33.9	101	13.1
72251	25	8,447	84	26.3	78	14.1
72261	26	9,353	94	28.8	86	14.6
72271	27	9,427	94	30.8	92	13.8
72301	30	11,080	111	35.1	105	14.2
		Av.	96	Av.	95	
	(US 35 aa X Deming 52-644) as pollinator at Nyssa, Oregon					
72022	2	10,437	104	37.0	99	14.2
72042	4	9,560	96	32.5	91	13.6
72052	5	9,317	93	28.8	82	15.2
72082	8	9,167	92	30.5	82	14.7
72102	10	8,103	81	26.7	80	13.9
72162	16	10,557	106	33.4	103	14.1
72192	19	10,787	108	33.8	105	14.6
72212	21	9,327	93	26.4	84	16.2
72222	22	9,723	97	31.9	101	14.0
72232	23	10,463	105	33.4	107	14.4
72252	25	10,173	102	28.9	92	15.7
72262	26	9,623	96	28.0	90	15.1
72302	30	10,370	104	33.9	109	13.3
		Av.	98	Av.	94	
028 (US 41)	(8-plot av.)	9,050	100	32.9	100	13.8

Type of replications: Systematic with US 41 as check. Percentage comparisons based on the two closest check plots are considered fairly reliable.

COMBINED DATA FROM UTAH AND IDAHO TESTS

It seemed advantageous to combine data from certain tests conducted at Jerome, Idaho, and at Taylorsville (or Salt Lake City), Utah.

At Salt Lake City an attempt was made to have two fertility levels (normal and extra-high nitrogen) for the tests with the Ovana hybrids and the hybrids to selected inbreds. However, the normal fertility turned out to be so high that adding 250 pounds N per acre made very little difference. There was some difference from an 8" versus a 14" spacing in these two tests, but the general performance of the varieties remained the same.

Beets from the Jerome, Idaho, tests were taken to Nyssa, Oregon, where sugar determinations were made by the Amalgamated Sugar Company. Frozen pulp was taken from the same samples and further chemical analyses were made at Salt Lake City. Since two sugar determinations were made from each sample, (one at Nyssa, Oregon and one at Salt Lake City), the figure used in the tables is the average of the two determinations. At Salt Lake City all sugar and purity (apparent purity) determinations were made by C. H. Smith.

Sodium, potassium and nitrogen values were made by Myron Stout. Sodium and potassium were determined with a flame spectrophotometer. Amino nitrogen was determined by the Stanek-Pavlas method using the spectrophotometer as an absorption instrument. The "amino N" values reported are based on the concentration of glutamine necessary to produce the same color. True "amino N" would be 0.097 times the values given. Mr. G. K. Ryser is responsible for all statistical analyses.

Designations:

MS = Cytoplasmic male sterility

aa = Mendelian male sterility

mm = Monogerm

MM = Multigerm

O V A N A   H Y B R I D S

DESCRIPTION OF HYBRIDS

SL 308 = Ovana fodder beet

SL 308+5 = F_1, (US 35 aa X Ovana)

SL 431+5 = b_1, US 35 aa X (US 35 aa X Ovana)

SL 630 = b_2, US 35 aa X (US 35 aa X Ovana) aa X CT8
(selected on size and % sucrose in the b_1 generation)

S.L. NUMBER	DESCRIPTION	ACRE YIELD SUGAR POUNDS	ACRE YIELD TONS BEETS	SUCROSE PERCENT	PURITY PERCENT	AMINO N PERCENT	PPM ÷ 10 Na	PPM ÷ 10 K	PERCENT CURLYTOP AUG. 1
		Jerome, Idaho - 8 replications each							
308	Ovana	3,305	13.1	13.1	89.8	.33	54	222	94.1
308+5	F_1	9,915	32.1	15.9	92.0	.34	29	248	14.8
431+5	b_1	10,510	31.4	17.1	92.6	.31	23	228	9.9
024	US 35	9,995	27.3	18.7	92.3	.32	16	194	7.9
630	(b_1 X CT8)	11,865	33.2	18.3	94.1	.34	19	174	3.5
	LSD 5%	1,040	3.19	0.54	0.97	NS	5	34	
		Salt Lake City, Utah - 20 replications each)(spacings combined)							
308	Ovana	2,939	15.9	8.4	70.6	.92	267	294	Severe
308+5	F_1	9,282	41.7	11.1	79.4	.83	129	399	----*
431+5	b_1	9,652	38.3	12.7	81.2	.90	100	407	----*
024	US 35	9,468	32.8	14.4	83.8	.82	86	415	----*
630	(b_1 X CT8)	12,084	40.9	14.8	85.4	.69	73	372	
	LSD 5%	856	3.59	0.56	1.60	.08	18	18	
		Salt Lake City, 8" versus 14" Spacing, Varieties combined							
8" Spacing		8,876	34.1	12.5	80.8	.79	128	371	
14" Spacing		8,411	33.7	12.0	79.4	.87	135	384	

* At Salt Lake City nearly all Ovana plants were badly injured by curly top. In the F_1 hybrid, very mild symptoms were evident on most plants but this did not appear to interfere with growth. For the other three more highly resistant varieties, mild curly-top symptoms were evident only on occasional plants.

HYBRIDS TO SELECTED INBREDS

TEST 1

S.L. NUMBER	DESCRIPTION	ACRE YIELD SUGAR POUNDS	ACRE YIELD TONS BEETS	PERCENT SUCROSE	PERCENT PURITY	AMINO N %	PPM÷10 Na	PPM÷10 K	PERCENT CURLY TOP AUG. 1
	Jerome, Idaho, - 8 replications								
211H3	US 22 MS	9,455	26.0	17.9	94.2	.31	29	198	9.2
5040H3	do. X CT4	10,204	26.7	18.8	93.6	.31	15	180	4.7
6103	do. X CT5	10,509	28.1	18.5	93.6	.27	17	178	3.5
7102	do. X CT8	10,288	27.3	18.6	93.4	.35	17	184	5.4
7104	do. X CT9	10,609	28.8	18.2	93.9	.32	24	187	3.5
6101	do. X (CT5XCT4)	10,536	26.8	19.3	94.1	.29	13	157	4.6
7103	do. X (CT5XCT8)	10,698	28.4	18.6	93.7	.30	17	172	4.7
702	(CT5XCT8)aa X CT9	10,685	27.6	19.2	94.5	.29	17	168	3.3
LSD 5%		NS	NS	0.46	NS	NS	5.48	12.0	
	Salt Lake City, Utah, - 20 replications (spacings combined)								
211H3	US 22 MS	8,908	34.0	13.1	83.0	.76	112	396	
5040H3	do. X CT4	9,888	34.7	14.2	84.8	.81	70	388	
6103	do. X CT5	10,459	37.8	13.8	84.5	.68	97	378	
7102	do. X CT8	9,526	33.3	14.4	84.9	.73	72	373	
7104	do. X CT9	10,278	36.3	14.2	85.1	.70	83	374	
6101	do. X (CT5XCT4)	10,043	33.9	14.9	85.6	.74	71	355	
7103	do. X (CT5XCT8)	9,909	33.5	14.0	84.7	.72	78	371	
702	(CT5XCT8) aa X CT9	10,001	32.8	15.3	86.3	.66	77	354	
LSD 5%		513	1.74	0.36	0.86	.045	9	11	
	Salt Lake City, 8" versus 14" spacing (varieties combined)								
8" spacing		9,901	34.11	14.54	85.58	.70	79	362	
14" spacing		9,852	35.45	13.92	84.17	.75	85	385	

1958 RESULTS WITH EASY-BOLTING SUGAR BEET VARIETIES BRAWLEY, CALIFORNIA

By Charles Price and
F. V Owen

Curly-top-resistant lines and hybrids developed at Salt Lake City were planted at the U.S.D.A. Southwestern Irrigation Field Station at Brawley, California. The planting date was September 15, 1957 and the beets were harvested April 14-18, 1958. Forty lines and hybrids were grown in two replications and each of eight special hybrids were included in twenty replications to obtain accurate data on combining ability. Plots consisted of single 30" rows, 42 feet long. The following page shows results with the eight hybrids from the replicated plots. Sugar and purity determinations were made by the Holly Sugar Corporation. Statistical analyses were made by George K. Ryser.

Soil type: Holtville silty clay loam.

Previous crops: 1952, flax; 1953, beets; 1954, sorghum; 1955-56, fallow; 1957, sugar beets.

Fertilizer used: 16-20-0, 200 pounds per acre applied October 10, 1957
Ammonium nitrate, 400 pounds per acre applied November 15, 1957

Thinning; October 7, 8 and 9, 1957

Irrigations: Seven total. First irrigation September 26, 1957.

Cultivations: Three cultivations and four hand hoeings.

Insect control: Cucumber beetles were controlled by spraying with DDT at the rate of two pounds per acre. Cabbage loopers were successfully controlled by spraying with DDT.

Disease problems: Curly-top exposure was light. Virus yellows infection reached approximately 100 percent by harvest, but reduction in root weight was not considered to be high because of the late date at which the beets were infected. Virus yellows was not observed until March, approximately two months prior to harvest. Experimental results in tests at Salinas, California, with virus yellows have shown that age of plant at time of infection has an important bearing on the amount of damage produced. The plants infected with virus yellows when young are more severely damaged from virus yellows than when infected later in growth. The percent sucrose might have been lowered, however, by virus yellows even though the infection came in late.

VARIETY TEST - BRAWLEY, CALIFORNIA, 1957-58

8 varieties
20 replications

By Charles Price

Planted September 15, 1957 Harvested April 14-18,1958

VARIETY	PARENTAGE	ACRE YIELD SUGAR Lbs.	ACRE YIELD BEETS Tons	SUCROSE Percent	PURITY Percent	BEETS 100'
7106	US 22 MS[1/] X SLC 125 mm	9,765	29.3	16.7	94.9	131
7103	" X (CT5 X CT8)	8,481	25.5	16.7	94.4	138
7105	" X CT5 mm	8,141	24.6	16.6	93.8	136
7107	" X 644 mm	8,085	25.9	15.6	83.7	129
7102	" X CT8	7,944	23.8	16.7	94.1	133
7211	6203 aa mm X 126 mm	7,154	20.0	17.9	94.1	136
7213	122 aa mm X mm Sugar sels.	6,619	18.6	17.9	93.9	128
7267	6603 aa mm X 122 mm	5,742	16.1	18.0	93.7	109
Check	US 56/2[2/]	8,950	25.7	17.5		133
General MEAN of all varieties		7,741	23.0	17.02	94.1	
S. E of MEAN		249	0.68	0.26	0.75	
Sig. Diff. (19:1)		697	1.96	0.73	NS	
S. E. of MEAN in % of MEAN		3.21	2.96	1.53	NS	

(Odds 19:1 = $2\sqrt{2}$ X Standard error of Mean

1/ = US 22 MS = SL 211H3 multigerm   2/ = US 56/2 check from border strips not replicated

VARIANCE TABLE
(for 8 varieties in test)

VARIATION due to	Degrees of freedom	MEAN SQUARES Gross Sugar	Tons beets	Percent sucrose	Purity
Between varieties	7	30,171,617	18.36	14.29	1.69
Between blocks	19	1,205,462	.36	1.67	5.04
Remainder (error)	133	1,239,997	.45	1.38	5.63
Total	159				
Calculated F value		24.53**	41.16**	10.43	0.30

** Exceeds the 1% point of significance (F = 2.79)

Designations:

aa = Mendelian male sterility
MS = Cytoplasmic male sterility
mm = Monogerm

THE INBRED CT5

The inbred CT5 arose from an exceptional beet selected at Jerome, Idaho, in 1952. This parental beet weighed 10.8 pounds with 20.2 percent sucrose. It came from an F_3 population derived from US 35 crossed to a high-sugar type self-fertile inbred. In the flowering stage the parental beet was highly self-fertile. All its offspring were also self-fertile, but there was unexpected segregation for Mendelian male sterility (aa). Segregation was also observed for hypocotyl color R r,for foliage type (a smooth, dark-green foliage with a sharply triangular leaf predominated), and for different degrees of curly-top resistance.

New sublines and methods of inbreeding

In 1953 selection from the S_1 CT5 offspring was made for curly-top resistance, root type and sugar content. This was followed by further evaluation and selection in succeeding years. Each year sib pollinations were made as well as self-pollinations and heterozygosity was maintained for hypocotyl color, for Mendelian male sterility and for type of foliage. In 1958 the sib hybrid SL 7004 was made available to the sugar beet industry. Maternal plants of SL 7004 were Mendelian male steriles while paternal pollinators consisted of forty different CT5 sublines. Certain CT5 sublines are now homozygous AA pollinators, while others are being held in the heterozygous Aa condition so they may be used either as pollinators or for female parentage by the genic aa emasculation.

Qualities of CT5

The sublines that make up the CT5 family of lines have a high degree of curly-top resistance combined with relatively good vigor. The root is long and remarkably free from sprangles. When the water level of the soil is too high CT5 beets develop scurf (water injury) accompanied by some vascular breakdown. In this respect it is not as bad as several other lines tested but it is nevertheless a weakness to be recognized. Certain selected CT5 sublines are excellent "type O" pollinators.

Combining ability

CT5 appears to have good to excellent combining ability. The F_1 hybrid, CT5 aa X CT9, tested in 1956, produced 13,158 pounds gross sugar per acre at Twin Falls, Idaho (17.1 percent above US 41).

Monogerm backcrosses to CT5

Monogerm lines have been recovered from hybrids to CT5. Utilizing these newly-recovered CT5 mm lines, three kinds of hybrids, MS MM X CT5 mm, MS mm X CT5 mm, and CT5 aa mm X mm, produced some of the best monogerm combinations tested in 1958.

CONTRASTS IN ROOT TYPE

Comparison of root shape of inbred lines when grown under favorable soil conditions. Jerome, Idaho, 1958.

Upper: Multigerm Inbred CT5
Lower: Monogerm Line SL 7271

MONOGERM HYBRIDS FOR GERM-PLASM RESERVOIRS

Heterogeneous populations simplify initial selection work and serve as reservoirs of valuable germ-plasm. Self-sterile populations may still have their place but self-fertility has many advantages when the primary objective is to extract and develop inbred lines. The key to the building of vigorous heterogeneous self-fertile monogerm populations has been the gene S^f for self-fertility and the gene a for abortion of pollen, otherwise known as Mendelian male sterility.

Population SL 7213 (SLC 122 aa mm X mm sugar selections)

SL 7213 is an example of a heterogeneous self-fertile monogerm population. The female parent, SLC 122 aa mm (SL 6216), represents several sublines of SLC 122 and carries a high degree of curly-top resistance. The pollinator was made up of 35 different monogerm lines carrying good curly-top resistance but principally selected for high sugar content. Eighty-nine pounds of SL 7213 seed was produced in 1957. The following comparisons between SL 7213 and US 41 (SL 028) were obtained in 1958:

VARIETY	ACRE YIELD Gross sugar pounds	ACRE YIELD Tons beets	Sucrose percent
Taylorsville, Utah, adjacent two-row strips			
SL 7213 mm	10,322	32.2	16.0
US 41	9,577	34.0	14.0
Taylorsville, Utah, 5 times replicated test			
SL 7213 mm	8,242	30.2	13.9
US 41	8,606	33.2	13.1
Taylorsville, Utah, under heavy nematode exposure			
SL 7213 mm		8.0	
US 41		12.3	
Jerome, Idaho, 6 times replicated test			
SL 7213	8,588	24.0	17.9
US 41	9,427	26.0	18.1

The above data show that SL 7213 was relatively productive but the point of most interest was the wide variation within the population which made mass selection work attractive. Preliminary evaluation of other somewhat similar monogerm hybrid populations is shown on the following page.

MENDELIAN (aa) HYBRIDS, BOTH PARENTS MONOGERM

S.L. No.	PARENTS aa mm	X	mm	TAYLORSVILLE, UTAH, 3 replics. ACRE YIELD GROSS SUGAR Lbs.	% BASIS	TONS BEETS	SUCROSE PERCENT	JEROME, IDAHO 3 replics. BEETS PER ACRE TONS	% BASIS	NEMATODE TEST - 4 REPS. SALT LAKE CITY TONS BEETS
7201	6216	X	644	7316	89	30.3	12.8	21.1	71	6.5
7202	6202	X	do.	7776	94	30.1	12.9	25.7	82	7.1
7204	117	X	609	8561	105	31.7	13.5	20.3	70	8.1
7205	647.2	X	do.	8469	101	30.4	13.9	20.7	77	8.1
7206	609	X	do.	7773	93	27.5	14.2	15.8	57	6.9
7207	117	X	125	7416	85	29.6	12.6	23.7	88	6.0
7208	53.71	X	do.	7440	87	27.3	13.5	23.6	87	3.7
7212	126	X	126	7744	93	28.9	13.5	20.9	78	5.0
7214	Misc. F_2	X	Sugar sels.	5935	70	23.3	13.6	22.2	82	6.0
7215	609	X	do.	8039	96	32.1	13.3	21.4	80	7.2
7216	611	X	do.	7987	98	30.7	15.0	21.4	80	8.6
7217	647.1	X	do.	9422	115	35.1	13.2	24.4	91	8.7
7218	647.3	X	do.	8525	103	32.9	12.7	25.1	93	7.4
7219	647.4	X	do.	8640	103	31.0	14.0	22.3	87	6.5
7220	647.5	X	do.	8729	104	32.0	13.6	22.7	89	5.9
7221	647.6	X	do.	9886	119	35.5	13.9	25.5	102	7.2
7222	647.16	X	do.	10086	112	34.9	14.5	23.5	94	4.8
7223	647.23	X	do.	9938	117	37.0	13.4	28.0	112	6.8
7224	647.24	X	do.	9510	114	34.1	13.8	22.6	91	11.4
7226	645.137	X	do.	8652	103	34.7	12.4	22.5	90	6.8
7227	645.341	X	do.	9075	108	32.0	14.1	20.0	80	9.2
7228	645.343	X	do.	8869	105	30.3	14.7	19.3	78	6.5
7229	646.344	X	do.	10725	127	36.7	14.7	19.9	79	6.7
7230	646.348	X	do.	8231	99	26.4	15.6	18.9	78	7.6
7231	646.351	X	do.	9493	113	32.5	14.7	24.8	97	9.7
7233	646.354	X	do.	9539	113	33.8	14.2	25.3	99	10.0
7234	646.358	X	do.	9177	110	32.0	14.4	22.3	85	6.3
7235	646.361	X	do.	10330	125	37.0	14.0	22.7	86	6.7
7236	646.362	X	do.	8626	101	30.0	14.4	23.8	93	7.2
7237	646.368	X	do.	7577	87	29.4	12.8	20.4	78	7.8
7239	646.375	X	do.	9146	105	33.2	13.7	28.0	106	9.8
7240	646.376	X	do.	8927	102	31.9	13.9	23.2	88	6.3
7243	646.379	X	do.	8716	100	29.7	14.7	23.3	89	7.3
7245	646.240A	X	sibs	9447	108	32.4	14.6	24.3	92	6.7
7246	646.243A	X	sibs	8667	99	29.5	14.7	20.3	77	7.7
7247	646.245A	X	sibs	8489	97	31.5	13.5	22.3	85	10.8
7248	646.247A	X	sibs	8071	93	27.3	14.7	20.1	77	8.1
7249	646.248A	X	sibs	9687	111	34.8	13.5	22.6	78	10.3
7260	6216	X	122	9078	106	29.8	15.2	21.1	73	9.4
7262	6202	X	do.	8554	99	28.6	15.3	21.1	71	7.9
7265	647.3	X	do.	9604	111	32.5	14.8	23.6	79	11.1
7266	647.5	X	do.	8316	106	33.0	14.1	20.8	69	6.9
7267	6603	X	do.	7746	89	28.0	13.9	10.4	46	5.8
7268	6607	X	do.	7478	85	27.2	13.8	16.7	54	6.4
7270	6617	X	do.	7252	93	27.3	13.1	18.2	58	6.0
7271	6623	X	do.	9241	97	26.5	14.0	21.3	68	6.0
7273	6216	X	do.	8318	107	30.3	13.7	18.9	60	6.2
7275	6204	X	sibs	7134	92	25.8	13.9	20.4	65	7.9
028	US 41 (8-plot average)			8214	100	30.2	13.6	24.5	100	12.3

Type of replications: Systematic with US 41 as check. Percentage comparisons based on the two closest check plots are considered fairly reliable.

UNEXPECTED TYPES OF MALE STERILITY

A few types of male sterility studied in 1958 turned out to be entirely new and there was some non-conformity to theories that have been postulated. Considerable effort has been made to reconcile the new and exceptional results. By hybridization to annual beets three generations were grown in 1958, and preparations have been made for more critical studies in 1959.

Examples of new and exceptional results are as follows:

First. A new type of Mendelian male sterility in a subline of the multigerm inbred CT9.

Second. Discovery of Mendelian male sterility in US 201B and in the CTR-LSR multigerm populations SP 561-0 and SP 562-0.

Third. Possible cytoplasmic influence on Mendelian male sterility. One example is the monogerm population SL 7215 (CT5 aa mm X mm sugar selections) with 25-30 percent male sterility expected but in which 91 percent male sterility was observed. A large amount of evidence shows complete independence of Mendelian male sterility (aa) from cytoplasmic male sterility (MS), but these exceptional results should be carefully investigated.

Fourth. A sudden change from cytoplasmic inheritance to Mendelian inheritance. The most disturbing example was population 7125 (MS mm X CT5 mm) with 21 male-sterile and 22 pollen-fertile segregates. In this population there was no indication of semi-male-sterility which usually characterizes cytoplasmic inheritance with imperfect "type O" pollinators.

Possibility of recovery genes

A strong recovery gene could explain the exceptional results with population 7125. There is also evidence for strong recovery genes in US 201 and in the CTR-LSR population SP 5551-0137. Genes which partially restore pollen fertility are common but strong recovery genes which restore full pollen fertility have been scarce in curly-top-resistant material. If fully reliable recovery genes can be established they may be valuable from the standpoint of eliminating the hand roguing associated with Mendelian male sterility.

BEET SUGAR DEVELOPMENT FOUNDATION
PROJECT 15 REPORT

By Myron Stout

Sugar beet varietal evaluation and selection studies

The beet sugar industry is becoming increasingly alarmed at the general reduction in quality of sugar beets. Acre yields have been increased through successful breeding for disease resistance and a large increase in the use of commercial nitrogen fertilizer. Yield of sugar per acre has been and will probably always be the most important single basis for the selection of superior varieties for producing of our commercial crop of sugar beets. Increased yield of sugar per acre is nearly always more easily achieved by increasing tonnage than by increasing sugar percentage. Low sugar percentage is usually associated with more impurities in the beet and greater processing losses.

Our information concerning the relative harmful effects of the individual impurities on extraction has not been well established, but the writer believes that a great preponderance of evidence indicates that nitrogenous compounds constitute the best single index of impurities that cause trouble in processing. Since Amino nitrogen is highly correlated with other nitrogen compounds in the beet and is easily determined, the writer has used that value as the index of nitrogen compounds in the beet.

Basic physiological facts have established the reasons why and how high nitrogen nutrition at harvest results in increased impurities and reduced sugar percentage. The three basic steps of nitrate-uptake chemical reduction from NO_3 to NH_3 and protein synthesis are all energy-requiring steps that reduce sugar storage in the root and produce an "impurity." Many nutritional and agronomic studies have also shown that high nitrate-uptake reduces sugar percentage and quality. High nitrate-uptake usually is accompanied by a large increase in the uptake of sodium and potassium.

Nitrate nutrition probably affects the quality of sugar beets far more than the differences between commercial varieties. However, most characters, including the uptake or synthesis of impurities, are heritable. In order to maintain or improve commercial varieties breeding lines must be thoroughly evaluated and those not genetically pure must be reselected to obtain lines with improved characteristics in regard to impurities as well as for sugar and yield.

In 1958 over 1300 individual beets of 88 lines selected in the field for size, shape and other characters, were evaluated for weight of root, sugar percentage, amino N, respiration rate, sodium and potassium. In addition to these values gross sugar per beet, gross sugar ÷ amino N percent, and sugar percentage ÷ amino N percent were calculated. Selections from promising lines were made after considering all characters and ratios. Some very outstandingly superior beets of the most promising lines were selected for breeding or increase. Although the two calculated ratios involving amino nitrogen make those values very heavily influenced by amino nitrogen percentage, they are being used only as quality indicators along with other constituents, until better quantitative indices of processing quality are found.

<u>Yield and quality performance of Ovana hybrids at two locations with widely different fertility and salinity levels.</u>

Some very interesting comparisons of both yield and quality of breeding lines of beets were obtained in tests of the Ovana variety and its hybrids conducted at Jerome, Idaho and Salt Lake City, Utah in 1958. The nitrogen fertility level at Jerome was good but not excessive. Salinity of the soil was low. Both nitrogen fertility and salinity were very high at Salt Lake City.

The hybrid, SL 630 [US 35 X (US 35 X Ovana)] X CT8, was outstanding for all measurements where significant differences were observed at both locations. Gross sugar per acre and purity of SL 630 was superior to all other lines in the tests at both locations. Where both salt and nitrogen content of the soil was high

(at Salt Lake City) the superiority of SL 630 was greater than at Jerome. At Salt Lake City all calculated ratios used this year in selecting superior individual beets, indicated a superiority for SL 630.

Curly top reduced the yield of Ovana seriously at both locations but the performance of the F_1 hybrid, SL 308+5, showed a high level of resistance as far as yield was concerned.

The very low potassium content of the roots of Ovana at Salt Lake City was not observed at Jerome; however, the K/Na ratio was lowest of the varieties in the test at both locations. Disease may have affected this relationship. A very low K/Na relationship was observed to be correlated with virus yellows infection a few years ago in beets grown at Riverside, California

The inbred CT8 was not considered to have very promising general combining ability in some crosses made in previous years but the performance of the hybrid SL 630 would suggest that it probably has excellent specific combining ability with some lines carrying genes of the Ovana variety.

OVANA VARIETY TEST, 1958

SL NUMBER	ACRE YIELD		SUGAR PERCENT	AMINO N PERCENT	PURITY PERCENT	Na PPM/10	K PPM/10	RATIOS		K/Na
	SUGAR LBS.	TONS BEETS						GROSS SUG. / N	% SUGAR / N	
			Jerome, 8 replications							
308 Ovana	3,305	13.1	13.1	.33	89.8	54	222	100	39.7	4.11
630 (b_1 X CT8)	11,865	33.2	18.3	.34	94.1	19	174	349	53.8	9.16
024 (US 35)	9,995	27.3	18.7	.32	92.3	16	194	312	58.5	12.11
431+5 (b_1)	10,510	31.4	17.1	.31	92.6	23	228	339	55.2	9.92
308+5 (F_1)	9,915	32.1	15.9	.34	92.0	29	248	292	46.8	8.55
Sig. Diff. 19:1	1,040	3.19	0.54	NS	0.97	5	34			
			Salt Lake City, 20 replications							
308 Ovana	2,939	15.9	8.4	.92	70.6	267	294	32	9.1	1.10
630 (b_1 X CT8)	12,084	40.9	14.8	.69	85.4	73	372	175	21.5	5.10
024 (US 35)	9,468	32.8	14.4	.82	83.8	86	415	115	17.6	4.83
431+5 (b_1)	9,652	38.3	12.7	.90	81.2	100	407	107	14.1	4.07
308+5 (F_1)	9,282	41.7	11.1	.83	79.4	129	399	112	13.4	3.09
Sig. Diff. 19:1	856	3.59	.56	.08	1.60	18	18			

Environmental factors that affect quality of sugar beets

It is almost universally recognized that nitrogen nutrition of the sugar beet should be very low for some time before harvest if high sugar percentage and high quality is to be achieved.

Experimental work conducted at Salt Lake City and elsewhere all seems to indicate that something can be done to improve quality with little or no sacrifice in sugar per acre. Experimental studies have shown that evaporation from the soil surface can cause nearly a ten-fold increase in the nitrogen content of the top inch of soil in a relatively short time. Other observations in arid climates corroborate the experimental evidence. It is obvious that in such arid climates this evaporative redistribution of nitrogen may be used to effect a lower nitrate concentration in the root zone before harvest and thereby increase sucrose percentage and reduce impurities. Irrigation in many fields using 20 or 22 inch rows amounts to flooding before harvest time arrives. It should be apparent that this type of irrigation reverses the evaporative redistribution of nitrate each time irrigation water is applied. By making deeper and better-formed, smooth furrows at the time of the last cultivation and by allowing no ponding at the bottom of the field, the beets can be supplied with the necessary moisture without upsetting the redistribution pattern in the soil profile between furrows.

Such agronomic practices should also reduce scurfing and root-rots in the crop before harvest due to inadequate root aeration. Another advantage would be the greater residual nitrogen left in the dry soil surface for succeeding crops.

Normal evaporative redistribution of nitrogen may be one of the basic reasons why double-bed ridge-planting has been most successful in certain sections of California, and might be advantageous in other arid climates.

Haddock has shown that higher quality beets were produced by furrow irrigation than by sprinkling. All nitrogen compounds were higher in the beets from sprinkled plots.

Alexander made some very pertinent observations in beets harvested in the Imperial Valley in July, 1958. At the time when the district average sugar content was 12.5 percent sugar and 78 percent apparent purity, beets with 16 percent sugar and 85 percent apparent purity were being delivered from four fields. The four fields delivering high quality beets averaged 22 to 26 tons per acre while the district average was 22.54 tons per acre. These four fields had two things in common. They had been deficient in nitrogen for three months and they had not been irrigated for at least two months. Apparently sub-irrigation was adequate to take care of the high rate of transpiration and allow the nitrogen redistribution pattern in the soil profile to develop to a high degree.

The writer believes that some of our agronomic and irrigation practices can be profitably re-examined with these two fundamental factors in mind. While the evaporative redistribution pattern is developing the beets will also be depleting the nitrogen in the root zone so that by harvest time the beets may be relatively low in nitrate-uptake.

Even where rains occur late in the season better hilling of the beets and deeper, better-formed furrows will probably reduce the negative effect of rains on the nitrate content of the root zone. The large leaves may shed some of the rain into the furrows and if they are deep enough to prevent flooding some advantages should result.

Cooperative studies at the University of Utah on the physiology of sugar beets.

Some very interesting work on the physiology of sugar beets is being continued at the Departments of Experimental Biology and Botany at the University of Utah. During the past year Max R. Harward (master's thesis) studied two varieties of beets grown in nutrient culture to which was added 0, 25, 50 and 75 milli-equivalents of NaCl, KCl and Na_2SO_4. The varieties studied were selected from breeding lines at Salt Lake City for large differences in sodium content of root tissue. The sodium content of root tissue of the two varieties, SL 308+5 an Ovana hybrid and SL 5070+5 a CT7 hybrid, behaved as expected from previous studies but the sodium content of leaf tissue of the two varieties was reversed from that of the roots, indicating a large difference in the distribution of sodium between roots and leaves in the two varieties studied. The CT7 hybrid having low root sodium (sometimes referred to as a sodium excluder) was found to have a high sodium content in its leaves. The Ovana hybrid having high root sodium was lower in sodium in the leaves.

Both chloride salts appeared to decrease the respiration rate of leaves as the concentration was increased, but sodium sulphate had little or no effect on leaf respiration. This would indicate that the chloride ion may be responsible for the decreased respiration rate of leaf tissue. As was experienced by the writer, rather wide variations in leaf respiration rates were observed on the same plants or treatments. The time of day the samples were taken, and the length of time they were stored before measurements were made appeared to affect the respiration rate greatly but not very consistently. These differences in factors affecting respiration rate of leaves is now the principal objective of a research project of another graduate student. The plants will be grown in a controlled environment on nutrient culture, so that most of the environmental effects can be studied independently.

VARIETY TEST, STATE COLLEGE, NEW MEXICO, 1958

In cooperation with the New Mexico Agricultural Experiment Station

(by J. C. Overpeck)

Field tests are conducted each year in cooperation with the New Mexico Agricultural Experiment Station to evaluate new varieties of sugar beets. Before the development of varieties with a high level of resistance to curly top, root yields were extremely low; but in recent tests the calculated yields have been above the national average.

The root yields this year were much below those of 1957. (see 1957 Report, p. 181) These lower yields can be attributed in part to the occurrence of leaf spot in addition to the usual severe epidemic of curly top.

Sucrose determinations were made on plot samples of roots, but the results were not available at the time of compiling this report.

In addition to the eight varieties in the replicated test given on page 44, plantings were made to evaluate basic breeding stocks at this location. The results of this test are not submitted in this report, but they have been supplied to the plant breeders supplying the material for the test.

VARIETY TEST, STATE COLLEGE, NEW MEXICO, 1958

IN COOPERATION WITH THE NEW MEXICO AGRICULTURAL EXPERIMENT STATION

6 replications in each date of planting

By J. C. Overpeck

Harvested December 29-30

Statistical analysis by Morris Finkner

VARIETY	TONS BEETS PER ACRE		BEETS PER 100' ROW		VEGETATIVE GROWTH		LEAF-SPOT READING	
	MARCH 13 Planting	APRIL 15 Planting	MARCH 18 Planting	APRIL 15 Planting	MARCH 18 Planting	APRIL 15 Planting	MARCH 18 Planting	APRIL 15 Planting
US 33 (LSL 333)	3.6	3.6	30	30	5.0	4.8	--	--
E-110* = SLC 91 MS mm X U-I 110	11.5	14.1	74	73	3.8	3.5	2.7	2.0
SL 7338 = SLC 117 MS mm X SP 554-0	9.2	12.1	64	60	4.1	3.4	3.0	2.3
SL 7339 = SLC 117 MS mm X SP 5651-0	10.1	11.8	61	56	4.0	3.3	2.8	2.2
US 22/4 (F 55-92)	11.8	17.8	64	82	3.5	3.2	2.7	2.5
SP 57109-0 LSR-CTR	13.8	18.0	77	77	3.2	2.7	2.0	2.0
SP 574-0 Incr. SP 554-0	10.4	13.9	64	61	3.3	2.8	2.5	2.2
SP 579-02 LSR CTR	14.4	14.5	76	69	2.8	2.8	2.0	2.2
Average	10.60	13.22						
LSD 5%	4.26	4.79						

Disease exposures:
Curly-top was severe. Cercospora leaf spot also became severe due to persistent rains in September.

Ratings for vegetative growth were from 1 to 6 on October 10, 1958. 1, is most healthy and vigorous; 6, all beets dead.
Ratings for leaf-spot injury were from 1 to 3 on December 3, 1958. 3, is most severe damage.

* E-110 is the Utah-Idaho Sugar Company commercial monogerm hybrid (also entered as SL 7337). The hybrids entered as SL 7338 and SL 7339 were also made by the Utah-Idaho Sugar Company.

CURLY TOP, STATE COLLEGE, NEW MEXICO, 1958

Upper: (a) Left of stake, 4-row plot of SP 57109-0.
(b) Staked row and 3 rows right, US 33 (SLC 333).

Lower: (a) Left of stake, plot of US 33 shown in upper photo.
(b) Staked row and 3 rows right, US 22/4 (F 55-92).

PART III

INTERSPECIFIC HYBRIDIZATION

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POLYPLOIDY IN RELATION TO CURLY TOP RESISTANCE

Foundation Project 11

Helen Savitsky V. F. Savitsky

Cytologist and Geneticist, Beet Sugar Development Foundation; and Collaborators, Crops Research Division, A.R.S., U.S.D.A., working under the supervision of the Sugar Beet Section, Salt Lake City, Utah.

INTERSPECIFIC HYBRIDIZATION

By H. Savitsky

1. Obtaining viable hybrids at different ploidy levels

Hybridization between different beet races from the species B. vulgaris and wild beets resistant to nematode from the section Patellares has been conducted for several years. The seed obtained was planted in the spring of 1958. From the hybrid seedlings, F_1 viable hybrids were obtained for the first time on a large scale. Hybridization was conducted at different ploidy levels. The female parent was always taken from the species B. vulgaris. Diploid sugar beets, fodder beets, red table beets and Swiss chard, as well as tetraploid sugar beets and tetraploid Swiss chard, were used as female parents. The pollinators were two diploid species, B. procumbens and B. webbiana, and a tetraploid species, B. patellaris.

Experimental results

The percentage of hybrid seedlings varied in different matings from 0 to 100. In 43 matings, from a total of 64, the proportion of hybrid seedlings exceeded fifty percent. Diploid, triploid and tetraploid hybrid seedlings were obtained (Tables 1 and 2). The diploid hybrids arose from hybridization of diploid plants from the species B. vulgaris with diploid species B. procumbens and B. webbiana. The tetraploid hybrids were obtained from crosses of tetraploid B. vulgaris (4n sugar beets and 4n Swiss chard) with the tetraploid B. patellaris.

The majority of hybrid seedlings were lethal as usual. They died three or four weeks after seed germination. Some seedlings in the lethal group perished after having developed small second or third pairs of leaves. The mortality of hybrids was caused by poor development of the root system. The seedlings which exhibited better root growth were able to develop a few leaves. From this background of high mortality some hybrid combinations showed different degrees of viability. The mating combinations were classified as viable, if a sufficient number of plants in the given combination developed to the flowering stage and were classified as low in viability when only few plants grew to the flowering stage.

The following matings were viable: 1. The diploid progeny No. 17 (see table 1) from hybridization of diploid Swiss chard to B. webbiana. 2. Among triploid hybrids three combinations showed low viability. In these matings the majority of plants died in the seedling stage or after development of a few leaves, but some hybrids grew well and became tall, vigorous plants. These hybrid combinations were derived from crosses of tetraploid Swiss chard with B. procumbens (progeny No. 7) and with B. webbiana (progenies Nos. 15 and 25). 3. The viable tetraploid hybrids were derived from crosses of tetraploid Swiss chard (progenies Nos. 10 and 12) and tetraploid sugar beets (progenies Nos. 8, 9, 19, and 31) with B. patellaris. Some tetraploid matings were low in viability (progenies Nos. 1 and 3). In these combinations only two or three hybrids grew to the flowering stage.

Viable combinations differed from lethal ones very strikingly. Many, if not all, seedlings in the viable combinations developed normally, or almost normally, from the first days of growth. Although their rate of growth was a little lower than in non-hybrid seedlings, they exhibited fair root and leaf development. But even in viable combinations some plants gradually became retarded in their development and died at different ages (some in the stage of two or three pairs of leaves; some after development of seed stalks).

All viable plants from viable and low viability matings were transplanted from flats into pots. They developed into vigorous, bushy, tall plants seven to ten feet high or sometimes higher. There were 18 diploid hybrids, five triploids, and 62 tetraploids which reached the flowering stage.

Diploid, triploid, and tetraploid hybrids differed in their appearance as well as in their rate of development. The first pair of leaves in tetraploid hybrids was usually very chlorotic, almost yellow. In triploid hybrids the first leaves were green; in diploids, the chlorophyll deficiency was intermediate between tetraploids and triploids.

The shape of the leaf blade differed also. The leaves in tetraploid hybrids had a broad base, like B. patellaris, but they were very large--even larger than

the leaves of sugar beets. The leaves in triploid hybrids were also broad, but elongated, and in diploids they were long and narrow.

The hybrids at the different ploidy levels were distinguished also by rate of growth and development. The most vigorous and earliest were tetraploids. They started to develop seed stalks and to flower earlier than any other hybrids. The first hybrid which started to flower was a tetraploid and it was five weeks old. One triploid plant started to flower almost at the same time; the others were later. The latest were the diploid hybrids. They developed slowly and started to flower only at the age of two and one-half or three months.

The wild beet types dominated in all F_1 hybrids. All of them developed seed stalks and flowered in the first year. The structure of the flowers and the type of inflorescence was also closer to the section Patellares.

All hybrids flowered abundantly. The anthers in diploid hybrids were small and unfilled (almost empty). Their color varied from transparent to yellow. They never dehisced. Among triploid hybrids the individual plants differed very much. Some triploids developed completely transparent and empty anthers. In other plants the anthers were yellow and comparatively well filled. They dehisced and pollen was shed on the stygma. The stygma lobes examined under binoculars were covered with pollen.

The tetraploid hybrids developed large, yellow, and comparatively well-filled anthers, but they did not dehisce.

In this way, all hybrids needed pollination by foreign pollen. Unfortunately, the supply of pollen was insufficient this season; therefore, complete data concerning seed setting could not be obtained. But the ability to produce seed could be observed in different groups of hybrids.

All diploid hybrids remained sterile. Triploid hybrid plants set a few seeds. Tetraploid hybrids were semi-fertile. Individual tetraploid plants differed in their ability to produce seed. From 0 to 30 seeds were obtained from different plants. A total of about 200 seeds were obtained from the hybrid plants. All hybrids

were trimmed and left for further growth and seed production. Some lethal hybrids were grafted. Among them were diploids, progeny No. 27; triploids, progeny No. 14; and tetraploids, progenies Nos. 20 and 21. The grafted seedlings developed into tall and bushy plants. Grafting did not change the ability of the hybrids to set seed whether diploid, triploid or tetraploid.

Conclusions

1. Experimental results obtained from hybridization of different *B. vulgaris* races with three nematode-resistant species, *B. patellaris*, *B. procumbens* and *B. webbiana*, showed that diverse viable hybrids with normal root development can be obtained if a sufficiently large scale of hybridization is used. Viable hybrids were not distributed at random among the hybrid material, but were concentrated in certain hybrid lines; i.e., those belonging to certain mating combinations. Only certain parental genotypes from the species *B. vulgaris* (mainly[1]) were able to produce viable hybrids. A larger diversity of genotypes involved in the hybridizations should provide better chances for obtaining viable hybrids.

2. Viable hybrids can be obtained not only by using "the bridge" represented by Swiss chard or by annual beets, but directly from crosses of sugar beets to species of the section *Patellares*. Not all hybrid matings with Swiss chard were viable, the majority of them were lethal like the majority of the matings with sugar beets. Only certain genotypes from Swiss chard populations, as well as only certain genotypes from sugar beet populations, were able to produce viable or semi-viable hybrid lines; although it may be possible that the concentration of such genotypes in Swiss chard populations may be a little higher than in sugar beet populations.

3. For the first time viable triploid and tetraploid hybrids were obtained. Obtaining polyploid hybrids opens new possibilities in hybridization between *B. vulgaris* and nematode-resistant species. It will be easier to overcome the

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[1] Pollen of the wild beets was collected from the whole population.

F_1 INTERSPECIFIC HYBRIDS.

The F_1 hybrids in seedling stage:
viable progenies, rows to the right in both flats
lethal progenies, rows to the left in both flats

Diploid F_1 hybrid in flowering stage.

Two tetraploid hybrids in flowering stage.

barrier of sterility and low viability at the higher ploidy level. It is also probable that the transmission of genes responsible for nematode resistance will be more successful in polyploids than in diploids, where more chromosomes are involved in meiotic associations.

II. Cytological study of F_1 interspecific hybrids between B. vulgaris and species of section Patellares.

A study of meiosis in the two F_1 hybrids (Swiss chard X B. webbiana, obtained by Gaskill, and Turkish Leaf beet X B. procumbens, obtained by Oldemeyer) leads to the conclusion that all diploid hybrids between B. vulgaris and species of the section Patellares will be completely sterile unless they develop diploid gametes from restitutional nuclei. Formation of restitutional nuclei with 18 chromosomes (9 from B. vulgaris and 9 from the wild beets) was the only way of obtaining viable gametes in this remote hybridization. The greater part of the microspores in the F_1 diploid hybrids contained fewer chromosomes than the haploid number (9). Some microspores were haploid (with 9 chromosomes), but they were not viable because the number of chromosomes from each species was much lower than the haploid number (for instance, 3 + 6 or 4 + 5, etc.); therefore, their physiological activity was limited. Only diploid gametes (with 18 chromosomes) or gametes with a chromosome number approaching this level, were viable.

The restitutional nuclei in these hybrids were formed:

1. When diakinetic nuclei entered the interphase without division. This resulted in a pollen mother cell with one large nucleus containing 18 chromosomes at interkinesis.

2. When in an asynaptic P.M.C. all 18 univalents divided in the first meiotic division, giving rise to P.M.C. with two large nuclei, each containing 18 chromosomes at interkinesis.

In both cases the restitutional nuclei arose from the asynaptic nuclei (without chromosome association).

In spite of the association of chromosomes of B. vulgaris with the chromosomes

[illegible] of [illegible] and low viability at the higher ploidy level. It is also [illegible] that the transmission of genes responsible for mosaic resistance will [illegible] successful in polyploids than in diploids, where more chromosomes [illegible] in meiotic association.

II. [illegible] study of F_1 interspecific hybrids between B. vulgaris and [illegible] B. [illegible] of B. [illegible].

[illegible] of [illegible] in the two F_1 hybrids (Swiss chard X B. webbiana, [illegible] Gadjil, and Turkish leaf beet X B. procumbens, obtained by [illegible]) leads to the conclusion that all diploid hybrids between B. vulgaris and [illegible] of the section Patellares will be completely sterile [illegible] they [illegible] from restitutional nuclei. Formation of restitutional [illegible] with 18 chromosomes (9 from B. vulgaris and 9 from the wild beets) was [illegible] way of obtaining viable gametes in this remote hybridization. The [illegible] of the microspores in the F_1 diploid hybrids contained fewer chromosomes than the haploid [illegible] (9). Some microspores were haploid (with 9 chromosomes), but they were not viable because the [illegible] of chromosomes from each species was [illegible] than the haploid number (for instance, 4 + 5 or 3 + 6, etc.); therefore, [illegible] logical activity was limited. Only diploid gametes (with 18 chromosomes) [illegible] with a chromosome number approaching this level were viable.

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[illegible] cases the restitutional nuclei arose from the asyndetic nuclei [illegible].

[illegible] association of chromosomes of B. vulgaris with the chromosomes

of the species from the section Patellares, the F_1 diploid hybrids are able to produce progeny from asynaptic restitutional nuclei only. Therefore, the first backcross progeny will always be triploid, or approaching to it, and will carry chromosomes of B. vulgaris and chromosomes of the wild species but not chromosomes with segmental interchanges. The segmental interchanges and transmission of genes responsible for nematode resistance from chromosomes of the wild beets to chromosomes of B. vulgaris are to be expected in later generations.

In this way F_1 diploid hybrids, as a rule, are not only sterile, but their progeny, if produced, will not carry intercrossed chromosomes. It does not mean, of course, that it is not necessary to obtain diploid hybrids, because translocations between chromosomes of different species may occur in later generations. It is obvious that polyploidy must be included in interspecific hybridization. It must be included first to avoid sterility. Polyploid hybrids may also render considerable help in the transmission of genes responsible for nematode resistance.

TABLE 1

F_1 Hybrids between 2n *Beta vulgaris* races and Nematode Resistant Species

PROGENY NUMBER	FEMALE PARENT (*B. vulgaris*)	POLLINATOR	NUMBER OF SEEDLINGS		PERCENT OF HYBRID SEEDLINGS	PLOIDY LEVEL OF F_1 HYBRIDS	VIABILITY OF HYBRIDS		
			non-hybrid	hybrid			LETHAL	VIABLE	Low in viability
	2n Sugar Beets								
26	Self-sterile mm N15	2n B. procumbens	1	0	0	2n	x		
27	Self-sterile mm N15	" "	10	82	89.1	2n	x		
32	US 22/3	4n B. patellaris	23	41	64.0	3n	x		
33	US 35/2	"	0	27	100.0	3n	x		
45	" "	2n B. webbiana	35	15	30.0	2n	x		
47	US 22/3	2n B. procumbens	10	28	73.6	2n	x		
51	Klein E	2n B. webbiana	5	15	75.0	2n	x		
52	US 35/2	4n B. patellaris	0	56	100.0	3n	x		
53	Janash	2n B. procumbens	6	13	68.4	2n	x		
55	US 22/3	4n B. patellaris	4	78	96.3	3n	x		
	2n Fodder Beets								
16	Ovana	2n B. webbiana	1	33	97.0	2n	x		
41	Barres	2n B. procumbens	15	56	78.0	2n	x		
	2n Red Table Beets								
18	Egyptian	2n B. webbiana	11	45	80.3	2n	x		
38	Detroit	" "	5	0	0	2n	x		
42	Egyptian	4n B. patellaris	10	62	86.1	3n	x		
43	Detroit	2n B. procumbens	22	60	73.1	2n	x		
	2n Swiss Chard								
4	Lyon	4n B. patellaris	10	0	0	3n	x		
5	Lyon	2n B. webbiana	4	35	89.7	2n	x		
13	Silber	4n B. patellaris	53	0	0	3n	x		
17	Lyon	2n B. webbiana	52	41	44.0	2n		x	
29	Lyon	2n "	10	56	84.8	2n	x		
35	Fordhook Giant	4n B. patellaris	45	52	53.6	3n	x		
48	Gruner Schnitt	4n B. patellaris	0	65	100.0	3n	x		
49	Lukullus	2n B. procumbens	21	82	79.6	2n	x		
54	Glatter Silber	2n B. procumbens	2	36	94.7	2n	x		
64	Lukullus	2n B. webbiana	25	10	28.5	2n	x		

TABLE 2

F_1 Hybrids Between 4n Beta vulgaris races and Nematode Resistant Species

PROGENY NUMBER	FEMALE PARENT (B. vulgaris)	POLLINATOR	NUMBER OF SEEDLINGS non-hybrid	NUMBER OF SEEDLINGS hybrid	PERCENT OF HYBRID SEEDLINGS	PLOIDY LEVEL OF F_1 HYBRIDS	VIABILITY OF HYBRIDS LETHAL	VIABILITY OF HYBRIDS VIABLE	VIABILITY OF HYBRIDS LOW IN VIABILITY
	4n Sugar Beets								
2	US 35/2	4n B. patellaris	0	26	100.0	4n	x		
8	US 35/2	" "	0	23	100.0	4n		x	
9	US 22/3	" "	15	5	25.0	4n		x	
19	US 35/2	" "	5	14	73.1	4n		x	
20	US 22/3	" "	1	65	98.4	4n	x		
23	US 22/3	2n B. procumbens	1	3	75.0	3n	x		
31	US 35/2	4n B. patellaris	0	11	100.0	4n		x	
36	Self-sterile N15	" "	10	35	77.7	4n	x		
46	US 35/2	2n B. procumbens	20	68	77.2	3n	x		
50	US 22/3	2n B. webbiana	5	0	0	3n	x		
61	US 35/2	" "	12	71	85.5	3n	x		
62	S. Ster. mm N15	3n B. procumbens	18	85	82.5	3n	x		
63	US 35/2	4n B. patellaris	10	88	89.7	4n	x		
	4n Swiss Chard								
1	Lyon	4n B. patellaris	0	26	100.0	4n			x
3	"	" "	71	3	4.0	4n			x
6	"	2n B. webbiana	4	35	89.1	3n	x		
7	"	2n B. procumbens	3	23	88.4	3n			x
10	"	4n B. patellaris	17	32	65.3	4n		x	
11	"	" "	65	5	7.1	4n	x		
12	"	" "	0	32	100.0	4n		x	
14	"	2n B. procumbens	4	11	73.3	3n	x		
15	"	2n B. webbiana	4	18	81.8	3n			x
21	"	4n B. patellaris	18	44	70.9	4n	x		
22	"	" "	52	34	39.5	4n	x		
24	"	2n B. procumbens	10	5	33.3	3n	x		
25	"	2n B. webbiana	70	11	13.5	3n			x
28	"	2n B. procumbens	6	4	64.7	3n	x		
30	"	" "	27	0	0	3n	x		
39	"	4n B. patellaris	6	45	88.2	4n	x		
40	"	2n B. webbiana	18	52	74.2	3n	x		
44	"	2n B. procumbens	0	5	100.0	3n	x		
56	"	" "	32	64	67.0	3n	x		
57	"	4n B. patellaris	15	0	0	4n	x		
60	"	4n "	10	72	87.8	4n	x		

RESISTANCE TO CURLY TOP IN DIPLOID AND TETRAPLOID BEETS

By V. F. Savitsky

Polyploid sugar beets have become the usual breeding material in many European countries in the last fifteen years. Polyploids are selected there for sugar and yield to produce varieties superior, in sugar content and tonnage, to the former diploid varieties.

In the United States, because of severe curly-top infection in many states, only varieties resistant to curly top can be cultivated. In connection with this, the study of curly-top resistance at different ploidy levels was undertaken.

Material. The tetraploid stocks studied in these experiments were obtained by H. Savitsky after colchicine treatment of the following diploid populations and inbred lines:

US 35/2	curly-top resistant, multigerm Z-type	C_5
US 22/3	curly-top resistant, multigerm E-type	C_4
US 104	curly-top resistant, multigerm E-type	C_2
US 401	leaf-spot resistant, multigerm	C_2
SLC 91	monogerm, self-fertile inbred line	C_5
SLC 91	monogerm, MS equivalent to SLC 91	C_5
SLC 15	monogerm, self-sterile	C_2

The tetraploid F_1 and F_2 hybrids studied were obtained from crosses of 4n US 35/2 MM self-sterile with 4n self-sterile monogerm stocks and with the 4n self-fertile monogerm inbred line SLC 91 mm.

Besides tetraploids, the corresponding diploid populations were also studied in these experiments.

Method of testing for curly-top resistance

The study of curly-top resistance in diploid and tetraploid beets was started at Jerome, Idaho, in 1953 by Albert M. Murphy. The tests were conducted under severe artificial curly-top infection. A reading of the grade of resistance to curly top was made by V. F. Savitsky for the individual plants in all experiments. A 10-grade scale was used for reading: Grade 1, plants completely free of curly-top infection; Grade 10, plants killed by curly top. Reading the grade of resistance for the individual plants made possible the determination of variability in curly-top resistance in the diploid and tetraploid beets.

A study of resistance to curly top was also conducted in 1958 in the experimental field at Salt Lake City under a severe natural curly-top exposure. The experiment was conducted as an 8 X 8 Latin square, using 2-row plots 50 feet long. Eight diploid and tetraploid panmictic self-sterile populations were studied. The hybrid diploid and tetraploid populations were tested at Jerome, Idaho, in 1958 under artificial infection.

EXPERIMENTAL RESULTS

Resistance to curly top in diploid and tetraploid populations

Analysis of variance showed that the natural infection by curly top was proportional for different plots; also for different rows and for different columns. The main factor of variability was the genotypic peculiarities of different varieties represented by the sum of squares (Table 1). In spite of the equal distribution, the infection by curly top was so severe that European diploid and tetraploid populations growing side by side (derived from European varieties, which are not resistant to curly top) were practically destroyed by curly top.

[illegible] of early-top resistance in diploid and tetraploid beets was [illegible] means, Idaho, in 1953 by Albert M. Murphy. The tests were con- [illegible] under severe artificial early-top infection. A reading of [illegible] to early top was made by V. F. Savitsky for the individual [illegible] all experiments. A 10-grade scale was used for reading: Grade 1, [illegible] symptoms of early-top infection; Grade 10, plants killed by [illegible] the grade of resistance for the individual plants [illegible] ion of variability of early-top resistance in the [illegible] here.

[illegible] resistance to early top was also conducted in 1953 in the [illegible] at Salt Lake City under a severe natural early-top [illegible] experiment was conducted as an 8 x 8 Latin square, using [illegible] 30 feet long. Eight diploid and tetraploid parthenogenic self- [illegible] were studied. The [illegible] diploid and tetraploid popula- [illegible] tested at Jerome, Idaho, in 1954 under artificial inoculation.

EXPERIMENTAL RESULTS

[illegible]

[illegible] of variance showed that the natural infection by early top was [illegible] for different plots; also for different rows and for different [illegible] The main factor of variability was the [illegible] peculiarities [illegible] varieties represented by the sum of squares (Table 1). In [illegible] infection by early top was so severe [illegible] tetraploid populations growing side by side (derived [illegible] which are not resistant to early top) were practically [illegible]

Table 1.--Analysis of Variance of curly-top grades in diploid and tetraploid populations. Plot data. Salt Lake City, Utah, 1958

Variation	Degrees of Freedom	Sum of Squares	Variance	Variance Ratio
Rows	7	0.2711	0.0387	1.73
Columns	7	0.3614	0.0484	2.17
Varieties	7	319.1407	45.5915	2042.63
Error	42	0.9374	0.0223	
Total	63	320.7106		

The average grade of curly-top resistance in eight European tetraploid populations was 9.6295±0.0636. The value of the variance was 1.1300±0.0957, which indicated that among these populations there was an absence of resistant or partially-resistant plants.

At the same time, the majority of plants in the diploid population US 35/2 developed normally, and the average grade of resistance in this population was 1.3469±0.0374. In this way, the conditions for evaluation of the grade of resistance in different varietal diploid and tetraploid populations were favorable in this experiment.

The tetraploid "equivalents" of the curly-top-resistant varieties (US 35/2 and US 104) appeared to be more resistant than the original diploid populations from which they were produced (Table 2). The significant difference for resistance to curly top between tetraploid and diploid US 35/2, in favor of tetraploids, equaled 0.2446±0.0418; and between tetraploid and diploid US 104, 0.1381±0.0483, also in favor of the tetraploids.

The leaf-spot-resistant diploid population, US 401, was very severely infected and the grade of its curly-top resistance was 7.9879±0.0908. In spite of this, this population was injured significantly less than the tetraploid strains from western Europe, with a curly-top grade of 9.6295±0.0636.

The resistance to curly top was highly increased in the tetraploid "equivalent" of the population US 401 when compared to its original diploid population and equaled 2.0442±0.0689. A significant difference in the grade of curly-top resistance between diploid and tetraploid US 401 populations was 5.9457±0.1140 in favor of the tetraploids. The injury in the diploid population US 401 was so high that the expression of many characters of the leaves and roots was changed by the virus in comparison with the tetraploid population US 401. The yield of roots in the diploid population US 401 was practically destroyed by curly top and hardly reached 31-32 percent of the yield of the roots of the diploid curly-top-resistant population US 35/2, while the average yield in the tetraploid US 401 population equaled the average weight of the root of the diploid US 35/2 population. Differences in foliage are shown in Figures 1 and 2.

The size of the leaves differed very much in diploid and tetraploid populations (Table 3). In the tetraploid US 401 population the length of the leaf blade reached 19.8360±0.0656 cent., while in the corresponding diploids the length of the leaf equaled only 7.3586±0.1446 cent. The width of the leaf in the tetraploid population was 32.7098±0.3657 and in the diploid only 10.8409±0.2619 centimeters.

The shift in the grade of resistance to curly top when diploids were turned into tetraploids was not caused by the sampling variability, because all tetraploid

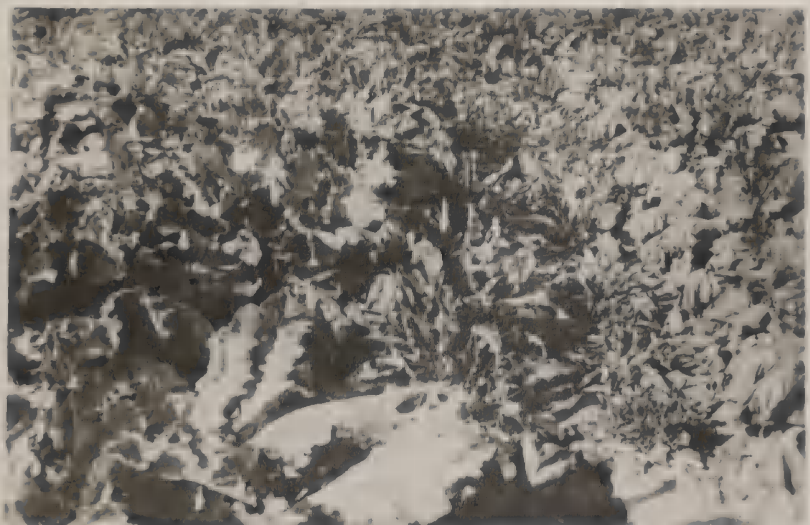
Table 2.--Curly-Top Resistance in Tetraploid and Diploid Populations of Sugar Beets at Salt Lake City, Utah, in 1958.

		Number of individual plants	Mean ± Standard Error	Variance ± Standard error of variance
US 35/2 Diploid		392	1.3469 ± 0.0374	0.5499 ± 0.0393
US 35/2 Tetraploid		352	1.1023 ± 0.0190	0.1282 ± 0.0097
Difference			0.2446 ± 0.0418	0.4217 ± 0.0404
Significant:	(001)		0.1089	0.1046
US 104 Diploid		388	1.3428 ± 0.0401	0.6227 ± 0.0447
US 104 Tetraploid		342	1.2047 ± 0.0271	0.2522 ± 0.0163
Difference			0.1381 ± 0.0483	0.3705 ± 0.0474
Significant:	(001)		0.1250	0.1228
2n 401 Diploid		396	7.9879 ± 0.0908	3.2354 ± 0.2299
2n 401 Tetraploid		317	2.0442 ± 0.0689	1.5032 ± 0.1194
Difference			5.9457 ± 0.1140	1.5677 ± 0.2642
Significant:	(001)		0.2953	0.6869
US 22/3 Tetraploid		379	1.1530 ± 0.0246	0.2275 ± 0.0165
F_3 (US 35/2 X US 22/3) Tetraploid		349	1.1351 ± 0.0239	0.2214 ± 0.0153
Difference (not significant)			0.0179 ± 0.0342	0.0061 ± 0.0225

Table 3.--Length and width of Leaves in Diploid and Tetraploid Populations of US 401 at Salt Lake City in 1958.

Populations	Number of Plants	Length in Cent. Mean ± Standard error	Width in Cent. Mean ± Standard error
Diploid	396	7.3586 ± 0.1446	10.8409 ± 0.2619
Tetraploid	317	19.8360 ± 0.0656	32.7098 ± 0.3663
Difference		12.4774 ± 0.1591	21.8689 ± 0.4506

Four rows in the center--the West European polyploid varieties susceptible to curly-top.



Left, two rows (beets with large leaves) tetraploid US 401. The next two rows to the right, diploid US 401 damaged by curly top.

populations were obtained from not less than 50 C_0 plants (sometimes from 70 plants) and the C_1 stecklings from which the C_2 seed was obtained grew under conditions which excluded selection for curly-top resistance. In this way, the possibility of selection for resistance during the process of obtaining tetraploid strains was excluded. Furthermore, all tetraploid populations showed the same type of changes--always a shift toward increased resistance to curly top when the diploid level was turned into tetraploid.

A higher expression of curly-top resistance in the tetraploid populations in comparison with the diploid original populations was manifest also under conditions of severe artificial infection at Jerome, Idaho during 1953, 1954, and 1956 (Table 4). Tetraploids obtained from the curly-top-resistant varieties US 35/2 and US 22/3 always showed higher resistance than their diploid ancestors, in spite of the fact that the injury caused by curly top was so severe that not only European susceptible varieties, but also some American varieties low in resistance (US 33), were completely destroyed.

The phenotypic curly-top resistance performance proved different for the same population (i.e., for the same gene pool) when the diploid level was changed to the tetraploid level. The difference in the genotypic curly-top-resistance interaction, specific for the level of ploidy (diploid and tetraploid) of the same gene pool, was established also for tetraploid F_2 hybrids in 1958. Several tetraploid F_2 families, obtained from crosses of tetraploid monogerm self-sterile beets low in curly-top resistance to tetraploid US 35/2, as well as several other tetraploid matings and corresponding diploid hybrids, were studied at Jerome, Idaho in 1958. The test showed that the tetraploid gene pool was potentially more effective in the creation of resistance to curly top than the diploid gene pool of the same diploid families which originated from crosses of diploid parents genotypically close to the populations from which the tetraploids were raised (Table 5).

TABLE 4

Curly-top resistance in Tetraploid and Diploid Populations of Sugar Beets under a severe curly-top exposure at Jerome, Idaho, in 1953,1954 and 1956

	1953		1954		1956	
	Mean ± St. error	Variance ± St. error	Mean ± St. error	Variance ± St. error	Mean ± St. error	Variance ± St. error
US 35/2 Diploid	3.5366 ± 0.0363	0.2147 ± 0.0237	1.4605 ± 0.0908	0.6184 ± 0.1004	2.1385 ± 0.1229	1.9612 ± 0.2434
US 35 /2 Tetraploid	2.9242 ± 0.0242	0.0765 ± 0.0094	1.1636 ± 0.0398	0.1727 ± 0.0233	1.4348 ± 0.0801	0.7968 ± 0.0972
Difference	0.6124 ± 0.0436	0.1382 ± 0.0255	0.2969 ± 0.0991	0.4457 ± 0.1241	0.7037 ± 0.1425	1.2244 ± 0.2615
Significant (001)	0.1129	0.0661	0.2577	0.3227	0.3705	0.6799
US 22/3 Diploid			1.6680 ± 0.0510	0.6311 ± 0.0571	4.1048 ± 0.1655	3.3740 ± 0.4282
US 22/3 Tetraploid			1.3095 ± 0.0534	0.3571 ± 0.0449	1.4779 ± 0.0758	0.6428 ± 0.0855
Difference			0.3585 ± 0.0738	0.2740 ± 0.0727	2.6269 ± 0.1841	2.7312 ± 0.5060
Significant (001)			0.1911	0.1883	0.4787	1.3200

TABLE 5

Curly-top resistance in 39 F_2 Tetraploid hybrid, self-sterile families compared with 39 diploid self-sterile families, at Jerome, Idaho, in 1958

Origin	Number of Individual Plants	Mean and Standard error	Variance ± Standard error of Variance
39 diploid families	2227	2.5963 ± 0.0259	1.5012 ± 0.1423
39 tetraploid families	2048	1.7705 ± 0.0222	1.0147 ± 0.1003
Difference		0.8258 ± 0.03456	0.4865 ± 0.1734
Significant (001)		0.0878	0.4474
US 35/2 diploid-population	115	2.3652 ± 0.0104	1.2368 ± 0.1631

From hybridization of tetraploid self-sterile monogerm beets, derived from the first self-sterile monogerm lines, which were low in curly-top resistance with tetraploids high in curly-top resistance (multigerm US 35/2) 39 F_2 brother-sister lines were studied. The average curly-top grade for these 39 tetraploid lines, based on the individual reading for 2048 plants was 1.7705±0.2222. In the same experiment their tetraploid parents showed the following grades of curly-top resistance: 1.4184±0.0947 and 3.1338±0.00885, respectively. The calculated average grade of curly-top resistance for both parents equaled 2.2760±0.0609. The tetraploid F_2 hybrids exhibited significantly higher resistance to curly top than the average resistance of both their tetraploid parents.

In the same experiment the average evaluation of the grade of resistance of 2227 plants in 39 diploid self-sterile lines was 2.5963±0.0260.

The grade of curly-top resistance in the diploid US 35/2 was 2.3652±0.0104 (Table 5). In this way, the resistance of tetraploid F_2 hybrids was higher not only in comparison with the grade of resistance in corresponding diploid F_2 hybrids, but it proved to be much higher than even the resistance of their original tetraploid parents.

<u>Variability in curly-top resistance in tetraploid and diploid beets</u>

Effect of polyploidy on resistance to curly top, as shown above, exhibits directional changes. Expression of curly-top resistance increases in many genotypes within the tetraploid populations. This stipulates a big difference in the average evaluation of curly-top resistance between diploid and tetraploid plants.

The study of variability of resistance to curly top within populations showed that polyploidy also causes a stabilizing effect. Because of this, a significant reduction in variance for curly-top resistance occurs (Tables 2 and 4).

The tetraploid populations were not only higher in curly-top resistance, but they were also more uniform in the grade of resistance. Reduction in variance for curly-top resistance was observed also under severe infection at Jerome, Idaho in

1953, 1954, and 1956, in tetraploid populations US 35/2 and US 22/3 (Table 4).

The tetraploid F_2 hybrids also showed a significantly reduced variance in comparison with that of the corresponding diploids (Table 5). However, this reduction of variance in tetraploids cannot influence negatively the effectiveness of selection for curly-top resistance in tetraploid populations in comparison with the diploids; 48.05 percent of the individuals in the tetraploid population are in the class with the highest curly-top resistance, while in the diploid population this class contains only 20.61 percent of the plants.

In this way, polyploidy is an important factor in breeding for curly-top resistance. Polyploidy makes it possible to improve the achievements of breeding for resistance obtained at the diploid level. It makes possible also the cultivation of varieties with an intermediate grade of curly-top resistance but valuable in other characters. For areas subject to severe curly-top infection, polyploidy may render a significant help for sugar beet cultivation. In areas where curly-top infection is not a yearly occurrence, usually adapted varieties low in curly-top resistance are cultivated. For many areas, polyploidy can increase the resistance in such varieties and protect them in years of curly-top exposure.

I express my gratitude to Mr. Albert M. Murphy for conducting for several years the experiments in the nursery at Jerome, Idaho.

PART IV

BREEDING FOR NEMATODE RESISTANCE

and

SCREENING TESTS IN FIELD AND GREENHOUSE

Foundation Projects 13 and 23

Charles Price C. H. Smith

and

Cooperators in Nematology Section

PROGRESS REPORT TO THE BEET SUGAR DEVELOPMENT FOUNDATION ON METHODOLOGY OF EXPOSURE AND BREEDING FOR NEMATODE RESISTANCE, SALINAS, CALIFORNIA, 1958.

(Foundation Project 13)

by Charles Price

Studies conducted with the support of the Beet Sugar Development Foundation are concerned with breeding for resistance to the sugar beet nematode. The approach to this problem has been primarily the screening of sugar beets by means of a technique developed at Salinas, California. This screening technique gives an exposure of a severe nature. The time required to complete a series of tests is long and greenhouse space is limited, but we have succeeded in testing several thousand plants. The number of beets which show any degree of resistance to the attack of nematode is so small that it is necessary to study large populations to get a few beets which seem promising. Many of the few selected do not survive the more rigorous test given them later. Selections for resistance have been made primarily on the basis of absence of adult female nematodes and newly formed cysts on the roots. However, we have noted that some individual beets are more vigorous and show less wilting than others despite the relatively high nematode population on the roots. These beets have been selected and are being brought to seed production and will be later tested for nematode tolerance. In selecting for resistance to nematodes, seedling sugar beet plants are grown in heavily infested soils in flats then transferred to infested soil in aluminum cylinders. The best plants are selected and transferred to larger containers and subjected to additional infestation. The final selections are grown to seed for further evaluation and test, and for crossing with other promising lines. Selections from heavily

infested grower fields are also made. Some of the selections made at Salinas and some made by American Crystal Sugar Company have performed better than unselected material in field tests at Salinas, California, and Salt Lake City, Utah.

In the breeding program, attempts are being made to combine resistance in various selected lines and to incorporate in sugar beet the high degrees of resistance found in some of the wild species of beet. The material which has been examined so far, and which is available in the breeding program, includes commercial varieties; promising monogerm lines; material from irradiated seed; and crosses between sugar beet and Beta maritima, B. webbiana, and Swiss chard.

Investigation is being done on the basic relationships of the nematode to the plant and to its soil environment, and investigation of possible control measures, such as crop rotation, use of trap crops, as well as selection and breeding for resistance.

A field on the U. S. Agricultural Research Station grounds has been selected in which an effort is being made to obtain a uniformally heavy infestation with nematodes in selected areas. This will be used for testing the effects of crop rotation on nematode injury and for testing resistance of selections and breeding material.

Tests are under way in which certain crops, such as Hesperis matronalis, are tested as a trap crop in control of sugar beet nematode. Hesperis matronalis apparently is able to stimulate hatching of nematodes from cysts in the soil, but it does not serve as a food plant for the hatched larva. This crop is being grown in the Salinas and Imperial Valleys in an

effort to study the adaptability of the crop under these two widely different environments.

Tests are being conducted at Salinas in 5-gallon crocks placed in the open field. One series of crocks contains soil with a high population of sugar beet nematodes, while the other series contains soil free of the nematodes. Selections of sugar beets for nematode resistance are planted in duplicate plots in series of 10 crocks each in the infested and non-infested soil. Some of the selections show better growth, less wilting, and lower mortality than the unselected checks, while others are little better than the unselected check. In some selections there is considerable segregation for vigor, and it is planned to select the best individuals of each of the selections in the test. Figure 1 shows the remarkable growth of one of the selections in this severe test.

A field test in cooperation with Dr. F. V. Owen, C. H. Smith, and Ed Jorgensen, Nematology Section, C.P.R.B., Salt Lake City, was continued in 1958, and Mr. Smith has a report of this test.

To subject selections for nematode resistance, it is necessary to plant the beets late in the spring or early in the summer. In seasons in which curly top is a factor, late plantings also give the selections a severe test for curly top resistance. Selections which have no curly top resistance, or only moderate degree of resistance, suffer severe damage regardless of their tolerance to nematode. This accounted for the poor showing of some of the selections this year.

Studies of the chemical nature of resistance to sugar beet nematode, in cooperation with Dr. J. M. Fife, Chemist at the Salinas Laboratory,

are being pursued to a limited extent. By use of chromatographic methods, it is found that certain amino acids are different in susceptible and in immune plants. It is hoped that this will eventually prove of value in the selection of the most resistant individuals of a population.

Greenhouse tests were conducted at Salinas, California, in which seedlings had been planted in heavily infested soil with damping-off fungi also present in the soil. In these tests, selections for nematode resistance have shown remarkable improvement in stand and seedling vigor over the unselected check plants. Figure 2 shows these comparisons. It is interesting that the material shown in Figure 2 was from greenhouse selections made at Salinas for nematode resistance, brought to seed for further evaluation, and the seed planted in a field test in which the soil was heavily infested with sugar beet nematode. The best individual beets from the field test were selected and brought to seed. This seed was planted in greenhouse flats and transplanted in the cotyledon stage to aluminum cylinders in which each individual beet was subjected to a severe test for resistance to a combination of sugar beet nematode and damping-off fungi. Greenhouse selections for nematode resistance made in this manner were much superior in vigor and stand to the unselected check.

NEMATODE RESISTANCE

Figure 1. Resistant selection shows vigor under severe exposure to <u>Heterodera schachtii</u>. Plants growing in crocks; one plant per crock.

On left: Soil not infested with nematodes.
On right: Soil heavily infested with nematodes.

Figure 2. Second generation of selection for resistance to <u>Heterodera schachtii</u>. Nema. Sel. 859 and US 41 growing in aluminum cylinders of nematode-infested soil. A combination of nematode attack and damping-off caused severe loss of plants of US 41, but all plants of Nema. Sel. 859 survived and made thrifty growth.

VARIETY TEST CONDUCTED UNDER SEVERE NEMATODE EXPOSURE
Salt Lake City, Utah, 1958

(Foundation Project 23)

by C. H. Smith

INTRODUCTION

The variety evaluations for nematode resistance in 1958 were conducted in the same nematode-infested field used in 1957. The test in 1958 was planted on land that had produced a good crop of sugar beets in 1957 following fumigation for nematode control. The field is located on the Rell Swensen farm at Taylorsville, a short distance from Salt Lake City, Utah.

Lines of sugar beets that had been selected for nematode resistance were obtained from the American Crystal Sugar Company, Rocky Ford, Colo.; the U. S. Agricultural Research Station, Salinas, Calif.; and the Salt Lake City nematode test of 1957. Sugar beet lines unselected for nematode resistance were provided from the breeding programs at Beltsville, Md., and at Las Cruces, N. Mex., as well as by the Utah-Idaho Sugar Company and Dr. F. V. Owen of the Salt Lake City Station.

Careful observations, prior to thinning, were made of all varieties for the presence of the nematode, *Heterodera schachtii*, and cysts were found on plants throughout the test. Conditions were ideal for growth during the seedling stage. Weekly irrigations provided good growing conditions for the late-planted test.

About June 1, beet leafhoppers were found in the test field; and by June 4, three to four leafhoppers per plant were observed. Although a good leafhopper kill was obtained through a spraying program, severe symptoms of curly-top developed, and the susceptible varieties were almost eliminated from the test by the disease.

DISCUSSION OF VARIETIES

Some varieties showing outstanding foliar growth in the 1957 nematode test field were down in general vigor because of a severe attack of curly-top. Comparison of nematode selected varieties from curly-top susceptible material with varieties having curly-top resistance was rather impartial and did not necessarily measure the true nematode-resistant quality of the variety. This manifests rather clearly the importance of selecting materials for nematode studies which have resistance to other common diseases of beet-growing areas.

In variety group number 1, an attempt was made to determine whether a late planting would give a better measure of nematode-resistant qualities in sugar beets than the normal early planting. The statistical calculations indicate a significant varietal X date of planting interaction.

Foliar wilting during warm summer afternoons was an outward expression of nematode injury. This type of evidence was particularly noticeable on many of the monogerm hybrids of group number three. Many numbers in this group produced heavy foliar growth. Curly-top resistance was high and general vigor good; however, root and top relationships in general were very disappointing. Root distortion was severe.

Some of the nematode-resistant selections made in 1957 (Group 7) were outstanding in root and top growth, although curly-top resistance was intermediate and some damage was evident.

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VARIETY TEST CONDUCTED UNDER SEVERE NEMATODE EXPOSURE
Salt Lake City, Utah, 1958

GROWER: Rell Swensen

SOIL TYPE: Welby fine sandy loam

PREVIOUS CROPS: 1952 alfalfa; 1953 grain; 1954, sugar beets; 1955, grain; 1956, sugar beets; 1957, sugar beets--nematode test field.

FERTILIZERS AND CULTURAL PRACTICES: Applications of manure and commercial fertilizers were used in conjunction with previous crop rotation. About 15 spreader loads of manure (chicken litter) and 200 pounds of ammoniated phosphate (20-40) per acre, was applied and worked into the soil during seed bed preparation.

PLANTED: Early planting, April 18, 1958. Late planting, May 29, 1958

THINNED: Early planting May 15, 1958. Late planting, June 20, 1958

IRRIGATIONS: First irrigation June 2. Total of thirteen irrigations by furrow.

SPRAYED FOR BEET LEAFHOPPER: Parathion one pint per acre, June 4. DDT emulsion, 25 percent on June 13.

HARVESTED: September 30, 1958. At harvest selections were made from outstanding varieties by hand digging, prior to the topping and weighing of each plot. Tops from the plots were removed with a roto-beater and beets scalped with tractor-mounted scalping tools supplemented by long-handled hoe work. Beets were counted before pulling. Plot weights were obtained but no sugar analysis was taken.

EXPERIMENTAL DESIGN: Beets were planted in randomized block design. Effective plot length of 21 feet with 20 inches between rows. The objective at thinning was six to eight inches but variations occurred. Four-foot alleys separated the ends of each plot. Beets were left in alleys for periodic examination for nematodes throughout the summer but were removed prior to harvest.

There were seven varietal groups. Group 1 consisted of seventeen varieties planted in randomized block design, replicated six times in two-row plots. It was included in two dates of planting in the unfumigated test field. This group of varieties was also planted in another field on the Swensen farm on soil fumigated with 20 gallons of Telone soil fumigant per acre by plow. Ten of the varieties were nematode selections made by the American Crystal Sugar Company, and the remainder were varieties known to be vigorous under normal growing conditions.

Group 2 consisted of eight varieties replicated six times in single row plots planted only at the late date of planting. It was made up of three American Crystal nematode selections, three vigorous inbreds and one hybrid from Salinas, California.

Group 3 was made up of 53 monogerm hybrids from Salt Lake City, planted in single-row plots at the late planting date, and randomized in four replications.

Group 4 consisted of sixteen CTR-LSR lines, sixteen monogerm lines and seventeen monogerm progenies from Beltsville, Maryland planted in single-row plots at the late planting date and replicated two to four times depending on quantities of seed.

Group 5 consisted of 73 vigorous hybrids from the Utah-Idaho Sugar Company. They were planted in single-row plots in the late planting and replicated from 2 to 7 times depending on seed quantity received.

Group 6 consists of greenhouse nematode selections made at Salinas, California.. Lack of adequate seed quantities limited planting to one single-row of each number.

Group 7 consisted of 44 numbers taken from varieties selected from the Salt Lake City 1957 nematode test field. The number of single-row replications varied with seed quantities available.

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

Fumigated versus unfumigated soil with uniform heavy nematode infestation

GROUP 1

S.L.NUMBER	VARIETY[1]	TONS BEETS PER ACRE Fumigated soil	TONS BEETS PER ACRE Unfumigated soil Early	TONS BEETS PER ACRE Unfumigated soil Late	BEETS PER 100' ROW Fumigated soil	BEETS PER 100' ROW Unfumigated soil Early	BEETS PER 100' ROW Unfumigated soil Late	Vigor rating 1-7 Early	Vigor rating 1-7 Late	Curly-top rating 1-5 Early	Curly-top rating 1-5 Late
7213	SLC 122 aa X mm 1955 sug.sel.	32.5	12.2	8.0	137	101	102	2.8	2.6	0.3	0.1
F54-4H7	CT9 MS hyb. X Klein E hyb.	44.7	19.8	13.7	103	108	96	2.5	2.4	0.4	0.3
6316	AC 56-407 Low Gal.	26.3	17.9	10.7	92	93	79	2.7	2.6	2.2	1.9
6317	AC 56-408 Int. Gal.	22.0	12.4	11.3	86	70	88	3.3	3.1	2.4	2.8
6318	AC 56-409 High Gal.	20.5	9.0	8.6	83	54	70	3.6	3.1	2.7	2.2
6319	AC 56-410	26.8	13.7	10.8	98	72	103	3.1	2.9	1.9	2.0
7318	AC (610 X 91) 108 MS X 56-406 Am. #2 type	33.8	17.2	11.6	102	104	98	2.4	2.5	1.1	1.4
7319	AC do. X 56-407	34.0	17.7	11.7	103	95	90	2.6	2.6	1.3	1.4
7320	AC do. X 56-408	30.0	17.5	12.9	104	90	91	2.4	1.2	2.5	1.4
7322	AC do. X 56-410	33.0	18.0	14.9	110	95	104	2.6	2.3	1.0	1.2
7323	AC Calcite groups Nem. sel.	30.7	15.5	14.2	97	87	90	2.9	2.6	2.1	2.3
7324	AC 56-406 Am. #2 type	30.4	18.3	10.8	99	108	87	2.4	2.4	0.8	1.2
7334	C 6503-13C2 Mildew res. inbred	27.2	16.5	6.3	78	84	58	2.8	3.3	2.7	3.1
7335	C 674H1 (461HO X US 201B)	32.2	17.4	13.1	113	85	86	2.4	2.2	0.9	1.3
7338	SLC 117 MS mm X SP 554-0	34.6	15.9	10.9	107	103	99	2.7	2.8	0.8	0.7
7339	SLC 117 MS mm X SP 5651-0	37.8	20.2	12.9	110	117	110	2.4	2.4	0.2	0.5
028	US 41 S.L.C.	36.4	19.6	11.9	114	115	93	2.3	2.6	0.2	0.2

[1] Variety descriptions: AC = Amer. Crys. Sugar Co. C = California by J.S.McFarlane. SLC = Salt Lake City by F.V.Owen
Results based on 6 replications - 2-row plots

VARIANCE TABLE

	Fumigated soil Mean Square	Fumigated soil Calc. F. value	Nematode soil-early Mean Square	Nematode soil-early Calc. F. value	Nematode soil-late Mean Square	Nematode soil-late Calc. F. value	Between early and late nematode soil Mean Square	Between early and late nematode soil Calc.F.value
Between dates							1256.07	148.47
Between varieties	201.58	10.02	54.77	5.05	29.94	4.94	63.91	7.55
Between varieties and dates							20.80	2.46
Between reps	57.49	2.86	134.23	12.37	21.85	3.60		
Remainder (Error)	20.12		10.85		6.06			
Remainder (Error pooled)							8.46	
Sig. Diff (L.S.D. 5%)	5.15		3.78		2.84		3.32	

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

Unfumigated soil with heavy nematode infestation

GROUP 2

S.L. NUMBER	VARIETY[1]	TONS BEETS PER ACRE	BEETS PER 100'	VIGOR RATING (1-7)	CURLY-TOP RATING (1-5)
6320	AC 55-410	9.8	86	3.5	2.7
6321	AC 56-412 Am.Cr. #2 type	9.3	73	3.2	2.1
7321	AC (610 X 91) 108 MS X 56-409	10.8	103	2.9	1.7
7331	C 5502 NB1 inbred	4.5	87	3.4	1.0
7332	C 5512 NB inbred	6.9	89	3.3	0.8
7333	C 5547 NB inbred	7.1	88	3.1	0.8
7336	C 8502 X Xi irradiated NB1	2.4	66	3.6	1.3
028	US 41	12.3	113	2.3	0.3

1/ Descriptions: AC = American Crystal; C = California by J. S McFarlane; SL = Salt Lake City entry number.

Results based on six replications - 1 row plots

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

Unfumigated soil with heavy nematode infestation.
Monogerm Mendelian male sterile (as mm) hybrids
from Salt Lake City, Utah

GROUP 3

S+ L. NUMBER	VARIETY (both parents monogerm)	TONS BEETS PER ACRE	BEETS per 100'	VIGOR RATING (1-7)	CURLY-TOP RATING (1-5)
7201	6216 X 644 mm	6.5	107	3.1	0.6
7202	6202 X do.	7.1	88	3.5	0.3
7203	6203 X do.	8.7	67	3.0	1.4
7204	SLC 117 X 609 mm	8.1	110	3.3	0.0
7205	647.2 X do.	8.1	110	3.1	0.3
7206	609 X do.	6.9	91	3.3	0.3
7207	SLC 117 X SLC 125 mm	6.0	98	3.4	0.3
7208	5371 X do.	3.7	87	3.5	1.0
7209	647.2 X do.	8.4	86	2.9	0.5
7211	6203 X CTR [redacted] lines	10.0	100	2.5	0.2
7212	Misc. seg. X do. (sibs)	5.0	102	3.1	0.5
7214	Misc. F_2 X mm 1955 sugar sel.	6.0	105	3.3	0.8
7215	609 X do.	7.2	87	3.1	0.3
7216	611 X do.	8.6	101	2.9	0.4
7217	647.1 X do.	8.7	108	2.8	0.8
7218	647.3 X do.	7.4	106	3.0	0.5
7219	647.4 X do.	6.5	94	3.3	0.5
7220	647.5 X do.	5.9	98	3.0	0.8
7221	647.6 X do.	7.2	106	2.9	0.6
7222	647.16 X do.	4.8	95	2.9	0.8
7223	647.23 X do.	6.8	112	2.9	0.6
7224	647.24 X do.	11.2	123	2.5	0.5
7226	645.137 X do.	6.8	104	2.8	0.5
7227	645.341 X do.	9.2	89	2.6	0.5
7228	645.343 X do.	6.5	98	2.9	0.8
7229	646.344 X do.	6.7	113	2.9	0.8
7230	646.348 X do.	7.6	102	3.2	0.8
7231	646.351 X [redacted] 1955 sugar sel.	9.7	99	2.3	0.3
7233	646.354 X do.	10.0	125	2.6	0.5
7234	646.358 X do.	6.3	96	3.0	1.3
7235	646.361 X do.	6.7	96	3.1	0.8
7236	646.362 X do.	7.2	99	2.8	0.6
7237	646.368 X do.	7.8	88	2.9	0.5
7239	646.375 X Sugar sel.	9.8	101	2.3	0.3
7240	646.376 X do.	6.3	105	2.8	0.8
7243	646.379 X do.	7.3	105	2.5	0.3
7245	646.240A X O.P. sibs	6.7	92	2.6	0.8
7246	646.243A X do.	7.7	117	2.6	0.3
7247	646.245A X do.	10.8	105	2.9	0.0
7248	646.247A X do.	8.1	100	2.6	0.5
7249	646.248A X O.P. sibs	10.3	111	2.6	0.3
7260	6216 X SLC 122 mm	9.4	113	2.5	0.5
7262	6202 X do.	7.9	86	2.9	0.0
7263	6203 X do.	6.7	89	2.6	0.6
7265	647.3 X do.	11.1	126	2.6	0.3
7266	647.5 X do.	6.9	71	3.1	0.8
7267	6603 X do.	5.8	90	3.1	0.3
7268	6607 X do.	6.4	94	2.9	0.8
7270	6617 X do.	6.0	99	2.8	0.3
7271	6623 X do.	6.0	91	2.8	0.0
7273	6216 X do.	6.2	101	2.8	0.5
7275	6204 X 6204 mm	7.9	105	2.8	0.0
7276	6205 X 6207 mm group	10.3	105	2.4	0.3

Results based on four replications - 1-row plots

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

Unfumigated soil with heavy nematode infestation
Varieties from Beltsville, Maryland

GROUP 4

ENTRY NUMBER	SP NUMBER	TONS BEETS PER ACRE	BEETS PER 100'	VIGOR RATING (1-7)	CURLY-TOP RATING (1-5)
	CTR-LSR Lines				
1	571-0	8.9	79	2.3	0.5
2	572-0	8.4	89	2.4	0.6
3	574-0	12.1	113	2.0	0.6
4	576-0	10.2	96	2.5	0.6
5	577-0	11.5	81	2.3	0.0
6	578-0	9.3	110	2.5	0.6
7	579-01	8.3	106	2.7	0.0
8	579-02	11.8	93	2.1	0.0
9	57103-0	11.8	115	2.4	0.4
10	57105-0	9.5	93	2.4	0.5
11	57106-0	11.0	107	2.4	0.3
12	57107-0	12.2	110	2.3	0.8
13	57108-01	7.4	85	2.6	0.8
14	57108-02	8.6	98	2.5	0.4
15	57109-0	13.2	93	2.0	0.0
16	57110-0	10.9	56	2.5	0.8
	Monogerm Lines				
17	57740-01	2.5	45	5.8	4.5
18	57741-01	1.1	36	6.3	4.5
19	57746-01	3.7	93	4.5	4.0
20	57749-01	3.7	60	5.5	4.5
21	57750-01	1.9	69	6.0	4.5
22	57751-01	5.8	79	4.0	3.8
23	57753-01	2.6	55	5.8	4.5
24	57754-01	3.9	74	5.3	4.5
25	57757-01	5.4	102	3.9	2.5
26	57773-01	4.4	57	6.0	4.5
27	57778-01	0.7	31	7.0	4.5
28	57779-01	1.0	71	5.0	4.5
29	57781-01	1.4	36	6.3	4.5
30	57783-01	0.6	33	7.0	4.5
31	57784-01	5.3	81	4.5	4.3
32	57791-01	3.9	76	5.5	5.0
33	57842-1	6.5	81	6.3	4.8
	Monogerm progenies				
34	57860-1	4.3	57	6.3	5.0
35	57864-1	5.3	76	4.8	4.5
36	57868-1	0.9	29	6.5	5.0
37	57869-1	6.7	86	4.0	3.5
38	57904-1	4.5	81	6.0	5.0
39	57909-1	3.4	86	6.3	5.0
40	57913-1	4.2	57	5.8	4.5
41	57915-1	3.2	76	6.0	5.0
42	57916-1	2.8	64	6.5	5.0
43	57916-1	5.4	86	5.3	4.5
44	57919-1	3.0	45	6.0	5.0
45	57923-1	3.6	86	6.0	5.0
46	57925-1	3.4	55	5.5	5.0
47	57927-1	2.0	83	6.5	5.0
48	57928-1	6.5	76	5.8	5.0
49	57929-1	4.2	67	5.0	4.5

Results based on 2 to 4 replications--1 row plots

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

Unfumigated soil with heavy nematode infestation
Varieties from the Utah-Idaho Sugar Company

GROUP 5

ENTRY NUMBER	VARIETY	TONS BEETS PER ACRE	BEETS PER 100'	VIGOR RATING (1-7)	CURLY-TOP RATING (1-5)
	Mendelian male sterile aa hybrids				
1	US 35 aa X CT9	10.4	100	2.8	0.8
2	do. X U-I 10	7.8	95	2.8	0.8
3	do. X U-I 11	10.5	98	2.6	1.3
4	do. X U-I 12	9.4	90	2.8	1.5
5	do. X U-I 13	12.2	133	2.8	1.8
6	do. X U-I 14	9.5	107	2.5	0.8
7	do. X US 201B	10.5	114	2.5	1.3
8	do. X AC 328	9.3	131	2.5	1.8
9	do. X FC 359	10.5	114	2.5	1.5
10	do. X FC 52-390	3.7	36	3.3	1.0
11	do. X FC 52-408	8.4	93	3.0	1.3
12	do. X FC 52-430	8.4	95	3.3	2.5
13	do. X FC 52-443	7.3	83	3.3	0.8
14	do. X FC 52-450	10.8	119	3.3	1.5
15	do. X FC 622	6.5	83	3.3	3.0
16	do. X FC 52-644	7.4	79	3.3	1.8
17	do. X Holly 2117-0	9.8	126	3.0	1.8
18	do. X SP 491001-0	6.2	64	3.0	1.5
19	do. X U-I 51	10.6	117	3.0	1.5
20	do. X U-I 52	9.0	102	3.3	0.8
21	do. X SL 5053	8.7	102	2.8	1.3
22	do. X U-I 54	9.6	93	3.0	1.8
23	do. X FC 53-326	8.5	124	3.5	1.0
24	do. X SL 238	5.2	88	3.0	1.3
25	do. X SL 5927 mm	9.8	112	2.5	0.5
26	do. X SL 4090	6.5	102	3.3	0.0
27	do. X ACSI-2	8.1	71	3.3	2.0
28	do. X ACSI-4	11.4	110	2.5	0.5
29	do. X Code 352 mm	5.2	90	3.3	0.8
30	do. X Code 404 mm	4.3	60	3.3	2.0
31	do. X Code 435 mm	11.8	95	2.5	1.8
32	do. X SL 42-287A	9.3	98	2.5	0.0
33	do. X 90HO	9.8	107	2.5	0.0
34	do. X Sug. sel. 202	15.3	79	2.0	0.0
35	do. X US 400	12.9	114	2.5	0.0
36	do. X U-I 114	13.7	93	2.2	0.5
37	do. X U-I 116	8.1	114	2.5	0.0
38	do. X Holly 391	12.2	110	2.8	0.8
39	do. X Am. #2	13.2	107	2.1	0.0
40	do. X Klein E	6.5	88	2.8	1.8

(Continued next page)

GROUP 5--continued

ENTRY NUMBER	VARIETY	TONS BEETS PER ACRE	BEETS PER 100'	VIGOR RATING (1-7)	CURLY-TOP RATING (1-5)
	Mendelian male sterile aa hybrids				
41	US 35 aa X Honiku 401	9.0	83	2.6	0.5
42	do. X Honiku 192	10.8	98	2.5	0.0
43	do. X SP 54104-0	12.6	86	2.1	0.0
44	do. X SP 5460	11.0	92	2.5	1.5
45	do. X US 401	11.8	102	3.0	0.8
46	SLC 117 mm X 91 mm	5.1	98	3.5	1.5
47	do. X 117 mm	6.5	62	3.3	1.3
48	do. X 108 mm	9.3	112	3.1	0.5
49	do. X 109 mm	7.0	126	3.5	0.8
50	do. X 110 mm	5.1	76	3.5	1.3
51	do. X 111 mm	5.3	74	3.1	0.5
52	do. X 113 mm	8.7	81	2.8	0.5
53	do. X 115 mm	8.7	90	2.8	1.0
54	do. X 116 mm	9.8	129	2.6	0.5
55	do. X SP 554-0	9.8	102	2.8	0.8
56	do. X SP 555-0	5.1	64	3.0	0.5
57	do. X SP 5651-0	9.1	88	2.8	0.0
58	601 aa X SP 556-0	8.0	83	3.3	2.1
59	do. X SP 557-0	6.5	98	3.5	0.5
60	do. X SP 558-0	4.8	60	3.3	2.0
61	do. X SL 119 mm	8.8	107	3.0	2.5
62	110 mm aa X SL 157	9.0	100	2.8	1.3
63	US 35 aa X SL 157	10.1	104	2.8	1.1
64	601 aa X U-I 13	10.0	94	2.7	1.8
65	SLC 122 mm aa X U-I 80	7.3	98	3.3	2.0
66	US 35 aa X IMCC 5	16.4	104	2.4	1.5
67	SLC 117 mm aa X SL 121 mm	8.4	92	3.0	0.9
68	do. X SL 122 mm	7.5	95	3.1	0.7
69	do. X SL 24 mm	8.1	94	3.0	1.5
	Self-sterile monogerm				
70	SLC 15 mm	7.3	90	3.0	1.5
71	SLC 18 mm	6.5	83	3.5	1.8
72	SLC 19 mm	5.9	77	3.3	1.5
73	SLC 24 mm	10.1	110	2.8	1.3

Results based on 2 to 6 replications - 1-row plots.

VARIETY TEST, TAYLORSVILLE, UTAH, 1958

Unfumigated soil with heavy nematode infestation
1958 nematode selections from Salinas, California

GROUP 6

ENTRY NUMBER	C - NUMBER	TONS BEETS PER ACRE	BEETS PER 100'	VIGOR RATING (1-7)	CURLY-TOP RATING (1-5)
1	58-308-1	11.2	105	3.0	3.0
2	58-309-1	7.8	62	3.0	3.0
3	58-310-1	14.0	95	3.0	2.5
4	58-311-1	12.3	105	3.0	3.0
5	58-312-1	11.8	57	3.0	3.0
6	58-313-1	9.8	90	3.5	3.0
7	58-314-1	11.8	86	3.5	4.0
8	58-315-1	10.6	100	3.0	2.5
9	58-316-1	12.3	105	3.0	2.5
10	58-317-1	8.4	100	3.5	4.0
11	58-318-1	11.2	71	3.5	4.0

Single replication - 1-row plots.

VARIETY TEST, TAYLORSVILLE, UTAH, 1958
Unfumigated soil with heavy nematode infestation
Selections from 1957 nematode plots.

GROUP 7

S.L. NUMBER	PARENTAL S.L. NUMBER	ORIGINAL VARIETY	TONS BEETS PER ACRE	BEETS PER 100'	VIGOR RATING (1-7)	CURLY-TOP RATING (1-5)
80.1	6316	56-407 AC	16.1	129	1.8	1.0
80.3		do.	11.2	98	2.3	1.5
80.5	6317	56-408 AC	9.7	102	2.8	2.7
80.6		do.	8.7	114	3.5	3.0
80.8	6318	56-409 AC	12.4	103	2.6	1.6
80.9		do.	13.1	98	2.6	1.6
80.11		do.	8.6	103	3.0	2.3
80.13	6319	56-410 AC	10.1	95	2.8	2.3
80.16	6320	55-410 AC	13.1	98	2.8	2.5
80.17		do.	16.1	81	1.8	1.0
80.18		do.	15.7	100	1.5	1.0
80.20		do.	10.7	85	2.8	1.8
80.23	6321	56-412 AC	13.0	95	2.7	2.5
80.25		do.	9.1	92	2.6	2.1
80.26	6346	C 6503-13C2	7.2	76	3.0	3.3
80.26A		do.	6.2	81	2.5	3.0
80.27		do.	4.5	57	3.0	2.0
80.27A		do.	5.0	57	3.5	2.0
80.29	6351	C 590-8	13.8	89	1.4	1.2
80.32		do.	10.9	105	2.0	1.5
80.33		do.	10.1	87	2.2	1.2
80.34		do.	9.3	117	2.3	0.8
80.43	6352	C 590-9	6.7	124	3.5	2.0
80.44		do.	5.0	52	3.5	2.0
80.45		do.	8.1	79	2.8	1.5
80.53	6353	C 590-12	9.0	100	3.0	2.0
80.54		do.	11.7	114	2.5	1.8
80.55		do.	12.0	90	2.5	2.0
80.57		do.	15.5	71	1.7	1.3
80.60	6354	C 592-3	11.8	110	3.0	1.5
80.61		do.	13.5	95	3.0	2.8
80.62		do.	8.4	100	3.5	2.5
80.63		do.	13.4	81	3.0	2.5
80.64		do.	12.9	110	3.0	3.0
80.65		do.	13.2	112	2.8	3.0
80.66		do.	17.8	87	2.0	1.3
80.67		do.	15.9	106	2.3	2.2
80.68		do.	13.4	86	2.0	1.5
80.75		do.	14.2	92	2.1	1.3
80.76		do.	8.7	87	2.5	2.1
80.77		do.	12.8	102	2.2	1.2
80.78		do.	12.8	110	1.9	1.3
80.80		747.14 aa mm X (80.3 etc.)	13.5	85	2.1	0.7
028		US 41	12.3	113	2.3	0.3

Results based on 2 to 6 replications - 1 row plots

P A R T V

VIRUS YELLOWS INVESTIGATIONS
and
BREEDING FOR YELLOWS RESISTANCE

Foundation Project 12

C. W. Bennett J. S. McFarlane

PROJECT 12

BREEDING FOR RESISTANCE TO VIRUS YELLOWS

J. S. McFARLANE and C. W. BENNETT

Work was continued at Salinas, California, in 1958 to determine which of our currently available varieties and breeding stocks possessed the highest degree of yellows tolerance. Varieties and breeding stocks which showed the least damage from yellows in the 1956 and 1957 tests were retested in replicated plots. Greenhouse and field selections were made for yellows resistance from a group of breeding stocks which possessed the highest degree of tolerance in the 1957 tests. Additional information was obtained on variation in resistance to infection. A study was undertaken to determine the mode of inheritance of yellows resistance.

Virus Yellows Resistance Evaluation Tests

Field tests were planted at Salinas on December 13, 1957 and May 1, 1958. The degree of resistance was determined by comparing inoculated and non-inoculated plots of each variety or breeding stock. Inoculations were made with a virulent strain of the yellows virus by means of the green peach aphid. Each replication was divided into 2 equal parts one-half of which was inoculated and the second half maintained as a check. (Figure 1).

The December planting consisted of separate tests of 8 bolting-resistant varieties and 8 bolting-resistant inbreds. Both the varieties and the inbreds were replicated 4 times. The plots were 2 rows wide by 40 feet long in the variety test and 2 rows wide by 25 feet long in the inbred test. Systox sprays for the control of

the aphid vectors of the yellows virus were applied at 7- to 10-day intervals, beginning March 3 and ending July 15. Inoculations were made on March 4. Percent spread of yellows to the non-inoculated plots was determined on June 20. The tests were harvested August 13-15.

The May planting included separate tests of 14 varieties or selections and 14 inbred lines. Four replications were used in both tests. The plots were 2 rows wide by 40 feet long in the variety test and 2 rows wide by 25 feet long in the inbred test. Spraying to control the aphid vector was started on May 20 and continued at 7- to 10-day intervals through August 15. Inoculations were made on June 25. Percent spread of yellows to the non-inoculated plots was determined on August 26. The plots were harvested September 10 and 11.

Infection ranging between 90 and 100 percent was obtained in nearly all inoculated plots in both dates of planting. Yellows gradually spread to the check plots but the spread occurred more slowly than in previous years. It is unlikely that the yields of the check plots were materially reduced by the yellows infection.

Reductions in yield and sucrose percentages for the 8 varieties included in the December planting are shown in tables 1 and 2. The reduction in yield of roots ranged from 26.2 to 44.0 percent. This difference was highly significant. Sucrose percentages were reduced in the yellows inoculated plots but the reduction varied from plot to plot. Occasionally an inoculated plot showed

a higher sucrose percentage than did the check plot. Results of the past 2 years indicate that yield data give a more accurate measure of yellows resistance than do sugar data.

Yellows reduced yields from 26.2 to 55.7 percent in the December inbred planting (table 3). This test included bolting-resistant inbreds which showed the highest tolerance in the 1957 tests and also the bolting-resistant NB2 inbred which was susceptible to yellows in 1957.

Yield reductions in the May planting are shown in tables 4 and 5. Losses for the 12 varieties ranged from 11.3 to 35.9 percent. Selections which had been made for virus yellows tolerance in the Netherlands (IRS numbers) showed the least damage. Yield losses for the 12 inbreds in the May planting ranged from 20.1 to 44.2 percent.

Varieties and inbreds which were selected as possessing tolerance to yellows in the 1957 tests tended to perform well in 1958. Two exceptions were the Amalgamated inbreds 5-148 and 6-278. These 2 inbreds proved to be very susceptible to infection and it is probable that the non-inoculated checks became infected soon after the inoculations were made in 1957, thereby giving an inaccurate comparison between the inoculated and check plots. Natural spread of yellows occurred more slowly in 1958 and the current results for these 2 inbreds are considered the more accurate.

The agreement between the results obtained with both the varieties and inbreds in the 2 dates of planting was reasonably

good. In the 2 variety tests 7547H1, 711, F57-554H1, and 368 received moderate yellows damage. The variety S1 was severely damaged in both tests. The 5511H1 variety was more severely damaged in the December than in the May planting. In the 2 inbred tests 5577-2, 7547, F57-554, and 5512 showed a moderate amount of damage. The 5502 inbred was more severely damaged in the December than in the May planting. The 5511 inbred was severely damaged in both plantings but the heaviest loss occurred in the December planting. Differences in growing conditions to which the plants were subjected in the 2 dates of planting probably account for a portion of the irregular varietal behavior.

Variation in Susceptibility to Infection

Counts were made in the unsprayed plots of both the December and May plantings to determine the relative resistance of the varieties and inbreds to natural infection with yellows. Counts in the December-planted variety test showed that infection among the 8 varieties ranged from 3.9 to 17.3 percent (table 6). This difference was significant at the 5-percent level. Differences observed in the spread among inbreds in the December-inbred test were not significant.

Natural infection occurring in the 14 non-inoculated varieties in the May variety test ranged from 2.2 to 18.2 percent (table 7). A range of 3.4 to 35.3 percent was observed in the May inbred test (table 8). Differences in these 2 tests were highly significant.

Counts were also made by I. O. Skoyen in an unsprayed variety evaluation test which was planted in a commercial sugar beet field

near Salinas, California on March 8, 1958. Only a moderate amount of yellows infection occurred in this field, which made it possible to obtain an accurate determination of the difference in spread among the 12 varieties included in the test. The amount of infection ranged from 15.0 to 34.7 percent (table 9). This difference was highly significant.

The results of the 1958 tests confirm those of 1957, showing that there are differences among varieties and inbreds in susceptibility to infection. These differences existed regardless of whether the beets were sprayed to control the aphid vectors of the yellows virus or left unsprayed. No relationship was found between resistance to infection and resistance to damage from yellows. Counts made in both 1957 and 1958 failed to show any clear-cut relationship between color of foliage and susceptibility to infection. Inbred lines with dark-green foliage showed a wide range in susceptibility to infection. Inbreds with light-green foliage tended to be susceptible; however, there were lines with light-colored foliage which showed only moderate infection.

Selecting for Resistance to Yellows

Field and greenhouse selections were made in 1958 from 8 self-sterile and 14 inbred lines. The self-sterile lines had shown tolerance in either the 1956 or 1957 tests. The inbreds had either shown promise in the 1957 test or were monogerm lines which had been selfed only 1 or 2 generations. Included were 3 yellows tolerant lines furnished by Dr. Henk Rietberg and 4 lines furnished

by Dr. Raymond Hull.

The field selections were made from a 2-acre plot which was planted in a checkerboard arrangement so that each plant occupied an area 28 x 28 inches. This planting arrangement tended to equalize competition between plants and reduced the danger of selecting large beets which had received an unfair competitive advantage.

Roots selected from this 2-acre planting are being thermally induced for seed production. Polycross seed, hybrid seed produced by exchanging bags, and selfed seed will be obtained in the greenhouse in time for field plantings in the late spring of 1959. Tests will be made to determine progress in selecting for resistance, and additional selections will be made.

Results with the second successive selection for yellows resistance in the US 75 variety proved disappointing in the 1958 tests. This selection, which is designated 711, showed a yield loss of 26.0 percent in the December test compared with 33.2 per cent for US 75. In the May test, 711 showed a yield loss of 27.1 percent compared with 28.9 percent for US 75. The difference in yellows damage between 711 and US 75 was not significant in either test.

The 2 successive selections which constitute 711 were both made from large populations of yellows inoculated plants. The first selection was made in the greenhouse on the basis of relative freedom from yellowing and necrosis. The second selection was made in the field and was based on both relative freedom from foliar symp-

toms and on root weight. Seed from both selections was mass produced. The results indicate either that US 75 lacks variability for yellows resistance or that mass selection is ineffective as a breeding method with yellows. Another rigorous selection was made from a one-quarter acre field planting of 711 in 1958. Seed will be produced and tested from the selected roots using the polycross method. In addition, outstanding roots will be mated with self-fertile lines to form the base for possible yellows resistant inbreds.

Inheritance of Resistance to Yellows

Included in the 1958 tests were 7 inbreds and 4 hybrids involving these inbreds. Results with these inbreds and their hybrid combinations are shown in table 10. In the December planting the hybrid combinations showed a marked improvement in yellows tolerance over either of the inbred parents. This was especially apparent in the MS of NB1 x NB2 combination in which the 2 inbreds showed losses of 46.4 and 55.7 percent, respectively, whereas the yield of the hybrid was reduced only 38 percent. In the May planting, the hybrids showed losses similar to or lower than that of the best performing inbred parent.

It is probable that relatively heavy losses suffered by the yellows-infected inbreds in the December planting may be explained by the poor growth they made during the winter and their weakened condition at the time of inoculation. In the May planting, the inbreds grew much more rapidly and were in a vigorous condition when inoculated.

Although it is impossible to draw any definite conclusions regarding inheritance, the results indicate that yellows tolerant inbreds can be expected to produce tolerant hybrids. The results with the hybrid involving the susceptible NB2 and the NB1 inbreds suggests that resistance may be partially dominant, because the hybrid showed a loss no greater than that of the more tolerant parent and much less than that of the susceptible parent.

Table 1. Effect of virus yellows on the performance of sugar beet varieties at Salinas, California. (Planted December 13, 1957 and harvested August 13-15, 1958)

Variety	Description	Acre Yield: Gross Sugar Check	Acre Yield: Gross Sugar Yellows	Acre Yield: Beets Check	Acre Yield: Beets Yellows	Sucrose Check	Sucrose Yellows	Harvest Count Check	Harvest Count Yellows
		Pounds	Pounds	Tons	Tons	Percent	Percent	Number	Number
F57-554H1	MS of NB1 x NB4	11,977	8,170	42.33	30.35	14.15	13.53	170	166
S1	Spreckels variety	11,742	6,329	39.53	21.93	14.93	14.48	164	164
5511H1	MS of NB1 x NB2	11,593	6,785	39.25	23.88	14.85	14.35	155	135
F57-86H1	(MS of NB1 x NB4) x 586	11,263	7,082	39.28	25.35	14.35	14.08	158	156
368	US 75	10,424	6,589	34.60	23.10	15.08	14.25	173	184
7547H1	MS of NB6 x NB5	10,309	7,566	36.05	26.40	14.35	14.35	151	148
711	2nd suc.v.y.sel. US 75	9,841	7,075	33.18	24.20	14.98	14.63	158	163
7569H0	MS of 6515 x 7569	9,315	6,774	27.73	20.88	16.93	16.28	130	136
General MEAN of all varieties		10,808	7,046	36.49	24.51	14.95	14.49	Beets per 100' of row	
S. E. of MEAN		298.9	419.7	1.35	1.35	0.45	0.42		
Significant Difference (19:1)		879	NS	3.98	3.96	1.33	1.23		
S. E. of MEAN in % of MEAN		2.77	5.96	3.70	5.51	3.01	2.90		

Odds 19:1 = 2.08 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES: Tons Gross Sugar Check	Tons Gross Sugar Yellows	Tons Beets Check	Tons Beets Yellows	Percent Sucrose Check	Percent Sucrose Yellows
Between varieties	7	3,783,892	1,372,053	85.84	34.72	3.02	2.52
Between replications	3	585,279	852,194	39.20	37.14	3.65	4.99
Remainder (Error)	21	357,446	704,773	7.30	7.25	0.81	0.70
Total	31						
Calculated F Values		10.59**	1.95(NS)	11.76**	4.79**	3.73**	3.61*

* Exceeds the 5% point of significance (F = 2.49)
**Exceeds the 1% point of significance (F = 3.65)

Table 2. Reduction in yield and sucrose percentage of sugar beet varieties when inoculated with the yellows virus at Salinas, California in 1958.

Variety	Description	Reduction in Yield: Gross Sugar	Reduction in Yield: Tons per Acre	Reduction in Sucrose
		Percent	Percent	Percentage Points
7547H1	MS of NB6 x NB5	26.5	26.2	0
7569H0	MS of 6515 x 7569	27.3	24.1	0.65
711	2nd suc. v. y. sel. US 75	28.2	26.0	0.35
F57-554H1	MS of NB1 x NB4	31.6	28.3	0.62
368	US 75	36.8	33.2	0.83
F57-86H1	(MS of NB1 x NB4) x 586	37.0	35.2	0.27
5511H1	MS of NB1 x NB2	41.2	38.0	0.50
S1	Spreckels variety	46.0	44.0	0.45
General MEAN of all varieties		34.3	31.9	
S. E. of MEAN		4.1	4.1	
Significant Difference (19:1)		12.2	12.1	
S. E. of MEAN in % of MEAN		11.95	12.85	

Odds 19:1 = 2.08 $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES: Gross Sugar	MEAN SQUARES: Tons Beets
Between varieties	7	211.11	193.18
Between replications	3	74.78	622.12
Remainder (Error)	21	68.20	67.53
Total	31		
Calculated F values		3.10*	2.86*

*Exceeds the 5% point of significance (F = 2.49).

Table 3. Effect of virus yellows on the yield of sugar beet inbreds at Salinas, California. (Planted December 13, 1957, and harvested August 13-15, 1958).

Inbred	Description	Acre Yield		Reduction in yield	Harvest Count	
		Check	Yellows		Check	Yellows
		Tons	TOns	Percent	Number	Number
5577-2	Bolt. res. inbred	20.45	14.83	26.2	146	154
7569	Monogerm inbred	15.63	11.08	28.6	122	130
7515C2	Monogerm inbred	16.25	11.03	31.4	108	110
7547	NB5 inbred	20.05	13.73	31.7	150	150
F57-554	NB4 inbred	25.43	16.15	36.2	180	164
5512	NB6 inbred	17.45	10.88	36.7	132	130
5502	NB1 inbred	22.90	12.20	46.4	146	142
5511	NB2 inbred	25.63	11.35	55.7	108	102
General MEAN of all varieties		20.47	12.65	36.6	Beets per 100' of row	
S. E. of MEAN		1.18	2.30	4.46		
Significant Difference (19:1)		3.47	6.75	13.12		
S. E. of MEAN in % of MEAN		5.76	18.18	12.19		

Odds 19:1 = 2.08 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES		
		Tons Check	Beets Yellows	Percent Reduction in yield
Between varieties	7	61.49	16.17	391.21
Between replications	3	17.81	3.65	97.51
Remainder (Error)	21	5.58	2.11	79.58
Total	31			
Calculated F values		11.03**	7.65**	4.92*

* Exceeds the 5% point of significance (F = 3.43)
**Exceeds the 1% point of significance (F = 6.14)

Table 4. Effect of virus yellows on the yield of sugar beet varieties at Salinas, California. (Planted May 1, 1958, and harvested September 10-11, 1958.)

Variety	Description	Acre Yield Check	Acre Yield Yellows	Reduction in yield	Harvest Count Check	Harvest Count Yellows
		Tons	Tons	Percent	Number	Number
56-1023-0	Inc. of IRS 55M24	22.0	19.4	11.3	101	109
56-1021-0	Inc. of IRS 55M9	21.1	18.2	13.3	89	96
715-1	Coons' virus yel. sel.	12.6	11.0	14.2	133	131
56-1022-0	Inc. of IRS 55M14	20.1	16.9	15.9	124	126
F57-554H1	MS of NB1 x NB4	27.9	22.1	20.6	126	123
718	Coons' sel. IRS M1-1953	18.9	14.3	24.2	143	141
5511H1	MS of NB1 x NB2	24.2	18.1	25.2	111	111
714-2	Coons' sel. from US 104	25.5	18.7	26.4	130	130
711	2nd suc. v. y. sel. US 75	26.4	19.3	27.1	138	135
7547H1	MS of NB6 x NB5	23.9	17.3	27.7	129	128
368	US 75	27.7	19.7	28.9	133	138
714-1	Coons' sel. from US 104	20.2	14.4	29.0	125	123
S1	Spreckels variety	26.8	18.4	30.9	134	133
716-1	Coons' sel. from US 201	13.8	8.8	35.9	111	108
General MEAN of all varieties		22.2	16.9	23.5	Beets per 100' of row	
S. E. of MEAN		0.82	0.65	2.60		
Significant Difference (19:1)		2.4	1.9	7.4		
S. E. of MEAN in % of MEAN		3.69	3.85	11.06		

Odds 19:1 = 2.02 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Tons Beets Check	MEAN SQUARES Tons Beets Yellows	MEAN SQUARES Percent Reduction in yield
Between varieties	13	92.51	52.08	232.65
Between replications	3	1.62	0.18	30.59
Remainder (Error)	39	2.71	1.70	26.97
Total	55			
Calculated F values		34.14**	30.63**	8.63**

**Exceeds the 1% point of significance (F = 2.64)

Table 5. Effect of virus yellows on the yield of sugar beet inbreds at Salinas, California. (Planted May 1, 1958, and harvested September 10-11, 1958.)

Variety	Description	Acre Yield		Reduction	Harvest Count	
		Check	Yellows	in yield	Check	Yellows
		Tons	Tons	Percent	Number	Number
55-RF393	American Crystal inbred	23.00	18.30	20.1	142	138
5614C2	Rust resistant inbred	22.10	17.43	20.3	138	136
SL7807	Multigerm inbred	19.10	14.78	22.4	134	136
F57-554	NB4 inbred	17.28	13.05	24.2	108	110
SLC117	Monogerm inbred	14.60	11.05	24.5	114	114
5502	NB1 inbred	17.30	12.95	24.8	110	108
SL6509	Large seeded mm inbred	16.03	11.63	26.3	118	124
5577-2	Bolt. res. inbred	19.48	14.33	26.4	128	124
5628-24C2	Bolt. res. inbred	19.53	14.13	27.4	120	120
7547	NB5 inbred	15.45	11.05	27.9	108	110
5512	NB6 inbred	19.33	13.55	29.8	134	132
6-278	Amalgamated inbred	14.25	9.60	32.0	92	94
5-148	Amalgamated inbred	21.83	13.78	36.0	128	130
5511	NB2 inbred	15.55	8.70	44.2	64	62
General MEAN of all varieties		18.20	13.16	27.6	Beets per 100' row	
S. E. of MEAN		1.35	0.89	2.88		
Significant Difference (19:1)		3.84	2.54	8.23		
S. E. of MEAN in % of MEAN		7.42	6.76	10.43		

Odds 19:1 = 2.02 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES		
		Tons Beets		Percent Reduction in yield
		Check	Yellows	
Between varieties	13	32.74	28.90	165.94
Between replications	3	33.86	11.98	64.97
Remainder (Error)	39	7.24	3.17	33.26
Total	55			
Calculated F values		4.52**	9.12**	4.99**

**Exceeds the 1% point of significance (F = 2.64)

Table 6. Percent spread of yellows to non-inoculated sugar beet varieties planted December 13, 1957, at Salinas, California.

Variety	Description	Plants Infected Percent
F57-554H1	MS of NB1 x NB4	3.9
5511H1	MS of NB1 x NB2	5.4
F57-86H1	(MS of NB1 x NB4) x 586	10.5
7547H1	MS of NB6 x NB5	10.5
711	2nd suc. v. y. sel. US 75	13.5
7569H0	MS of 6515 x 7569	14.3
S1	Spreckels variety	17.2
368	US 75	17.3
	L. S. D. (5%)	7.5

Table 7. Percent spread of yellows to non-inoculated sugar beet varieties planted May 1, 1958 at Salinas, California.

Variety	Description	Plants Infected Percent
715-1	Coons' v. y. sel.	2.2
5511H1	MS of NB1 x NB2	5.4
718	Coons' v. y. sel. IRS M1-1953	6.7
F57-554H1	MS of NB1 x NB4	8.6
56-1022-0	Inc. of IRS 55M14	10.9
7547H1	MS of NB6 x NB5	11.0
56-1023-0	Inc. of IRS 55M24	13.0
714-1	Coons' v.y. sel. US 104	13.4
714-2	Coons' v.y. sel. US 104	13.7
56-1021-0	Inc. of IRS 55M9	13.8
716-1	Coons' v.y. sel. US 201	14.0
368	US 75	15.8
711	2nd suc. v.y. sel. US 75	15.9
S1	Spreckels variety	18.2
	L. S. D. (5%)	5.3

Table 8. Percent spread of yellows to non-inoculated sugar beet inbreds planted May 1, 1958 at Salinas, California.

Inbred	Description	Plants Infected Percent
5502	NB1 inbred	3.4
5554	NB4 inbred	4.3
5577-2	Bolt. res. inbred	5.3
5512	NB6 inbred	5.4
SL 7807	Multigerm inbred	5.5
5614C2	Rust res. inbred	7.2
SL6509	Large seeded mm inbred	9.7
5511	NB2 inbred	10.5
5547	NB5 inbred	10.8
55-RF393	American Crystal inbred	11.4
SLC117	Monogerm inbred	15.8
5628-24C2	Bolt. res. inbred	20.1
5-148	Amalgamated inbred	23.2
6-278	Amalgamated inbred	35.3
	L. S. D. (5%)	6.7

Table 9. Percent spread of yellows to non-inoculated sugar beet varieties planted March 8, 1958 at Salinas, California.

Variety	Description	Plants Infected Percent
7512H3	(MS of NB1 x NB4) x NB6	15.0
7615H2	585HO x 7615	19.8
787H1	(MS of NB1 x NB4) x 787	21.3
581H2	(MS of NB1 x NB2) x 581	21.6
F57-86H1	(MS of NB1 x NB4) x 586	23.1
7508H1	(MS of NB1 x NB4) x 7508	26.0
663H2	(MS of NB5 x NB1) x 663	26.3
368	US 75	30.4
787H2	(MS of NB5 x NB6) x 787	30.7
787	Bolt. res. sel. US 75	33.1
459	US 56/2	33.6
7569H2	461HO x 7569	34.7
	L. S. D. (5%)	6.7

Table 10. Percent reduction in yield of sugar beet inbreds and their hybrid combinations when inoculated with yellows at Salinas, California in 1958.

Inbred or Variety	Description	Reduction in yield
		Percent
	December 1957 Planting	
5502	NB1 inbred	46.4
F57-554	NB4 inbred	36.2
F57-554H1	MS of NB1 x NB4	28.3
7547	NB5 inbred	31.7
5512	NB6 inbred	36.7
7547H1	MS of NB6 x NB5	26.2
5502	NB1 inbred	46.4
5511	NB2 inbred	55.7
5511H1	MS of NB1 x NB2	38.0
7569	Monogerm inbred	28.6
7515C2	Monogerm inbred	31.4
7569HO	MS of 6515 x 7569	24.1
	May 1958 Planting	
5502	NB1 inbred	24.8
F57-554	NB4 inbred	24.2
F57-554H1	MS of NB1 x NB4	20.6
7547	NB5 inbred	27.9
5512	NB6 inbred	29.8
7547H1	MS of NB6 x NB5	27.7
5502	NB1 inbred	24.8
5511	NB2 inbred	44.2
5511H1	MS of NB1 x NB2	25.2

VIRUS YELLOWS, SALINAS, CALIFORNIA, 1958

Figure 1. A portion of a field in which breeders' selections and varieties of sugar beet were evaluated for resistance to virus yellows. Half of each plot was inoculated with yellows virus; the remaining half was retained as a check.

Side view: The inoculated portion of one series of plots is shown at the left; the noninoculated portion of an adjoining series of plots is shown at the right.

Figure 2. Side view of seed plots of Inbred 6532-29. Marked dwarfing and yellowing of plants are evident in the inoculatd plot. Yields are shown in Table 11.

Left: Check plot.
Right: Plots inoculated with yellows virus March 4, 1958.

THE EFFECT OF THE VIRUS YELLOWS DISEASE ON SUGAR BEET SEED PRODUCTION

C. W. Bennett and J. S. McFarlane

Introduction

Tests in Europe indicate that the virus yellows disease of sugar beet may cause even greater losses to the seed crop than to the crop grown for sugar. Most of the sugar beet seed production in the United States is concentrated in the Salt River Valley of Arizona, in western Oregon, southern Utah, and in the Hemet Valley and the Tehachapi area of California. Yellows was first observed in the Salt River Valley in 1955, and there has been high percentages of infection in some fields in each succeeding year. Yields were abnormally low in 1955, 1956, 1957 and 1958.

The yellows disease has been present in western Oregon, at least since 1952. Information with respect to damage caused by yellows is not available, but low yields in some fields in 1957 and 1958 indicate that the disease may become an important factor in seed production in that area. No evidence of serious losses caused by yellows in the Hemet Valley has been obtained. Yellows and beet mosaic, in combination, undoubtedly cause measurable reduction in yield of seeds in the Tehachapi area, but the effects of yellows alone are difficult to determine.

This distribution of the yellows disease indicates that it is likely to be a serious problem in seed production in all seed-producing areas in western United States. Experiments were

initiated in 1956 in the Salinas Valley to obtain additional evidence on the effect of the disease on yield and quality of the seed crop.

Methods and Procedures

The mean temperatures prevailing in the Salinas Valley during the winter are too high for satisfactory seed production in commercial varieties of sugar beet. For this reason, it is necessary to use easy-bolting selections or to subject commercial varieties to periods of low temperature in cold rooms before transplanting them to the field, to obtain satisfactory seed production.

An annual type of beet, SL 54484+0, obtained from F. V. Owen, was used in the 1956-57 test. The planting was made November 5, 1956. The plots were 12.5 feet long and 4 rows wide, and the plants were thinned to about 4 inches in the row. The treatments consisted of (a) inoculation with yellows virus March 18 before bolting started, (b) inoculation with yellows virus May 13 when the most advanced plants had a few open blossoms and (c) non-inoculated checks. Plots were inoculated also with curly top virus alone and in combination with yellows virus, but no curly top infection was obtained. These plots were considered additional check and yellows plots, respectively, and results are shown in Table 11 along with results from other plots in the test. Treatments were replicated 4 times. Plots were harvested August 8.

The variety US 33 and an easy-bolting inbred, designated 6532-29, were used in tests in 1957-58. Plants of both types were started in the greenhouse in aluminum cylinders, stored 2 months in a room held at about 42° F. for thermal induction, then transplanted to the field in November. Treatments consisted of (a) inoculation with yellows virus March 4 when the plants were beginning to bolt, and (b) noninoculated check. Plots consisted of 25 plants in each of 4 rows. Treatments were replicated 6 times.

An additional test was made with the inbred 6532-29 in plots seeded directly in the field November 15, 1957. Treatments consisted of (a) inoculation with yellows virus March 4 before bolting started, (b) inoculation May 12 when fruiting stalks were about 12 inches tall, and (c) noninoculated check. Treatments were replicated 8 times. Plots were harvested August 5 and 6.

In the tests of both years, plots were sprayed at intervals from November until the plants were in blossom, to reduce spread of yellows to check plots. High percentages of plants in the check plots remained free of symptoms in the 1956-57 test and in the direct-seeded plots of the inbred 6532-29 in the 1957-58 test. However, there was some spread of virus to check plots in the transplants of the 1957-58 test as early as March, and by harvest time more than 50 percent of the plants in the check plots showed evidence of infection. High percentages of infection were obtained in all inoculated plots. A virulent strain of the yellows virus was used for inoculations in all tests.

Results

The results of 4 tests are combined in Table 11 which shows the calculated yields of seed per acre, percent damage, average weight of 100 seeds, and percent germination of seed.

Yellows produced a marked reduction in yield of seeds in all tests. The inbred 6532-29 appears to have a relatively high degree of susceptibility to injury. Reduction in yield in March-inoculated beets reached 54.2 percent in the transplants and 70.2 percent in direct-seeded beets. Yellowing and necrosis were severe on mature leaves of plants, and the disease markedly reduced size of fruiting stalks and set of seed. Relative size of seed stalks and degrees of yellowing in noninoculated check plots and plots of this inbred inoculated March 4, are illustrated in Figure 2, page 101.

Diseased plants produced smaller seeds in all tests. The reduction in seed size was significant at the 5-percent level in March-inoculated plots of 1956-57 test and at the 1-percent level in all other tests in which inoculations were made in March. May inoculations produced less reduction in seed size.

Germination of seeds was unusually low in all tests and there was wide range of variation in germination of seeds from different plots, particularly in the 1956-57 test with the selection SL 54584+0. There is no evidence from these results that yellows caused a reduction in germination of seeds.

On the basis of the results obtained in these tests, it seems evident that if plants are infected with yellows before

bolting begins, reduction in yield of seeds may be very high. Later infections apparently produce correspondingly lower reductions in yield. It seems evident, also, that there may be a wide range of variation among breeder's strains, and perhaps among commercial varieties, with respect to susceptibility to injury by the yellows disease.

Table 11. Results of tests at Salinas, California, in 1956-57 and 1957-58 to determine the effects of virus yellows on yield and quality of sugar beet seed.

Variety or selection tested	Date inoculated with yellows virus	Calculated yield of seed per acre	Calculated reduction in yield of seed per acre	Average weight of 100 seeds	Germination
		Pounds	Percent	Grams	Percent
SL 544840 (Direct seeding)	March 18, 1957	2,068	44.5	1.421	53.9
	March 18, 1957[1]	1,981	43.4	1.434	52.5
	May 13, 1957	3,034	18.6	1.680	62.6
	Noninoculated	3,727		1.698	58.2
	Noninoculated[2]	3,498		1.698	58.3
	L.S.D. at 5%	724		.250	NS[3]
	L.S.D. at 1%	1,096		NS	NS
US 33 (Transplants)	March 4, 1958	2,394	44.6	1.468	76.1
	Noninoculated	4,321		1.732	79.1
	L.S.D. at 5%	535		.030	NS
	L.S.D. at 1%	838		.046	NS
6532-29 (Transplants)	March 4, 1958	1,865	54.2	1.246	59.1
	Noninoculated	4,072		1.520	57.1
	L.S.D. at 5%	599		.139	NS
	L.S.D. at 1%	939		.218	NS
6532-29 (Direct seeding)	March 4, 1958	793	70.2	1.245	59.4
	May 12, 1958	2,098	21.1	1.358	51.1
	Noninoculated	2,658		1.497	52.6
	L.S.D. at 5%	460		.150	NS
	L.S.D. at 1%	638		.208	NS

[1]Inoculated with both curly top and yellows viruses but no curly top infection was observed.

[2]Inoculated with curly top virus but no infection was observed.

[3]NS indicates that results are not significant.

PART VI

DEVELOPMENT AND EVALUATION
of
INBRED LINES AND HYBRID VARIETIES OF SUGAR BEETS
SUITABLE FOR CALIFORNIA

Foundation Projects 24 and 29

J. S. McFarlane I. O. Skoyen

Cooperators conducting tests:

Holly Sugar Corporation
Spreckels Sugar Company
Union Sugar Division
Charles Price - Brawley Test
R. S. Loomis, Agronomy Department,
University of California

REPORT ON FOUNDATION PROJECT 24

Summary of Accomplishments

J. S. McFarlane

The principle objective of Project 24 continues to be the development of breeding stocks which combine resistance to bolting and curly top. Attention is given to downy mildew resistance, inheritance studies, and to polyploid breeding.

MONOGERM BREEDING.--The incorporation of the monogerm character into breeding stocks which combine resistance to bolting and curly top again received top attention in 1958. More than 500 monogerm segregates were selected from 25 F_2 populations involving crosses between multigerm and monogerm lines. The parents of these F_2 populations included curly top resistant Type O multigerms, high sugar multigerms, mildew resistant multigerms, leaf spot resistant multigerms, bolting resistant monogerms, and curly top resistant monogerms from the Salt Lake City program. Seed of these new monogerm selections has been planted at Salinas and in Oregon. Superior lines based on bolting resistance, vigor, seed setting ability, curly top resistance, mildew resistance, and sucrose content will be selected in 1959. Seed increases will also be made of the more promising lines.

A monogerm inbred resembling NB1 is being produced through the use of the backcross method. Increases of the more promising backcross lines are being made in 1959. The male-sterile equivalents of these lines are also being produced.

DOWNY MILDEW RESISTANCE.--Monogerm selections were made from the F_2 population of a cross between the highly mildew resistant 7508 multigerm and the 7507 monogerm. The mildew resistant hybrid 7508H1 with the parentage (MS of NB1 x NB4) x 7508 performed well in all coastal area tests. The mildew resistant inbred, 7508, which was used as the pollen parent in this hybrid, was distributed in 1957.

SEED RELEASES.--A total of eleven new breeder's strains were distributed in 1958. Included were bolting resistant monogerm inbreds, bolting resistant multigerm inbreds, and a bolting resistant selection from US 201B. Descriptions of two multigerm inbreds and three monogerm inbreds,which were made available for increase, are shown on the next page.

	NB5	NB6	7507mm	7515mm	7569mm
Bolting	Resistant	Very res.	Resistant	Resistant	Mod. res.
Curly top	Mod. res.	Very res.	Susc.	Susc.	Mod.res.
Vigor	Very good	Moderate	Poor	Moderate	Moderate
Pollen	Good	Good	Poor	Good	Good
Type O	Good	Good	Fair	Good	Fair

The MS of NB5 x NB1 has proved to be a high performing male-sterile parent for use in producing bolting resistant hybrid varieties. The NB6 inbred possesses more bolting resistance than any inbred developed in the Salinas program but has not shown particularly good combining ability. The general combining ability of the two monogerm inbreds, 7515 and 7569, proved to be average to good with a definite trend to improvedsugar. In 14 tests, the hybrid 461HO x 7569 yielded an average of seven percent more gross sugar than did US 75, and the sucrose percentage averaged 15.91 for the hybrid compared with 15.47 for US 75. In six tests, the hybrid 5515HO x 787 produced four percent more gross sugar than did US 75 with an average sucrose percentage of 16.66 compared with 16.07 for US 75. The MS of 7515 x 7569 was inferior to US 75 in yield but possessed excellent sugar. It showed good vigor, seed setting ability, and male sterility in the Oregon seed plots. Curly top resistance was equal to that of US 33 in tests at Jerome, Idaho. Top cross hybrids were produced, using MS of 7515 x 7569 as the female parent and 663, 787, and 586 as the pollen parents.

The monogerm inbred 7507 proved to lodge badly in Oregon. It will undoubtedly be of greatest value as a breeding stock.

EVALUATION AND COMBINING ABILITY TESTS.--Tests to determine the combining ability of new inbreds were made by the USDA at Salinas and Brawley. Cooperative company tests were also made in the coastal area, the Imperial Valley, and the central valley. The University of California conducted a test at Davis. Results of these tests, together with summary tables, are included in this report. The male-sterile parents MS of NB1 x NB3, MS of NB1 x NB4, and MS of NB5 x NB1 continued to perform well in hybrid combinations. The new bolting resistant selection from US 75, designated C787, yielded as well as did US 75 but averaged slightly lower (0.24%) in sucrose content in six tests.

NEW HYBRID VARIETIES.--Two new hybrid varieties designated US H2 and US H3 are being released for commercial use. US H2 has the parentage (MS of NB1 x NB3) x 663 and US H3 is a combination of (MS of NB1 x NB3) x Bolt.res. US 35. Both hybrids have very good curly top resistance and moderately good bolting resistance. The hybrids are adapted for planting in the Imperial and central valleys.

The results have been especially promising in the Imperial Valley as is shown by the following summary table:

Variety	Year	Number of Tests	Performance in % of US 75: Acre Yield Sugar	Acre Yield Beets	Sucrose Content
US H2	1957	3	118	116	103
US H2	1958	7	124	122	101
US H3	1957	2	108	102	104
US H3	1958	7	106	101	104

TYPE O SELECTIONS.--Indexing work was continued with major emphasis being placed on the identification of Type O monogerm self-fertile lines. A total of 215 index progenies were produced by I. O. Skoyen and are being classified in the greenhouse.

POLYPLOIDY.--Increases are being made of tetraploids produced in NB1 and other inbred lines. Arrangements have been made with Dr. Bernstrom of the Hilleshog Sugar Beet Breeding Institute in Sweden to produce triploid hybrids involving our male-sterile diploids and their better tetraploids. One group of triploids will be produced at Salinas in 1959. A somewhat similar arrangement has been worked out with Dr. Sydney Ellerton of Bush Johnsons Limited in England.

Descriptions for Varieties Included in Summary Tables

US H2	=	(MS of NB1 x NB3) x NB, CT sel. (US 15 x US 22/3)
663H2	=	(MS of NB5 x NB1) x NB, CT sel. (US 15 x US 22/3)
787H1	=	(MS of NB1 x NB4) x Bolt. res. US 75
US H3	=	(MS of NB1 x NB3) x Bolt. res. US 35
F56-66H2	=	(MS of NB1 x NB2) x Bolt. res. US 35
F57-86H1	=	(MS of NB1 x NB4) x Bolt. res. US 35
7508H1	=	(MS of NB1 x NB4) x 7508 inbred
7615H2	=	585HO x 7615 inbred
7569H2	=	461HO x 7569 mm
7569H3	=	(MS of NB1 x NB3) x 7569 mm
787H2	=	(MS of NB5 x NB6) x Bolt. res. sel. US 35

Gross sugar yields of bolting resistant hybrids and commercial varieties in 1958 California variety tests, expressed in percent of the yield of US 75

Location	Testing Agency	US 75	US 56/2	US H2	663H2	787H1	US H3	F56-66H2	F57-86H1	7508H1	7615H2	7569H2	7569H3	787H2
Coastal Area														
Salinas	USDA	100	94	-	121	113	-	-	113	109	124	108	-	110
Salinas	Union	100	94	109	113	110	93	107	113	106	121	105	-	104
Alisal	Spreckels	100	98	-	-	-	-	-	105	-	-	-	-	105
Spreckels	Spreckels	100	86	-	114	-	-	-	111	118	-	91	-	102
King City	Union	100	101	119	114	122	104	109	112	112	-	109	113	110
King City	Spreckels	100	-	-	111	-	-	-	-	-	-	-	-	-
San Ardo	Union	100	107	117	117	125	109	118	124	115	-	118	119	115
Gilroy	Spreckels	100	-	-	104	-	-	-	-	-	-	-	-	-
Betteravia	Union	100	102	101	127	127	85	118	115	120	-	107	-	115
Alvarado	Holly	100	96	110	-	-	91	111	108	-	-	-	-	-
Central Valley														
Tracy	Holly	100	91	103	-	104	96	101	103	93	-	108	100	-
Ryer Island	Holly	100	92	100	-	-	-	-	-	-	-	-	-	-
Davis	U.of Calif.	100	-	108	-	122	-	-	-	-	-	111	108	-
Imperial Valley														
Brawley	USDA	100	96	117	-	116	104	-	110	-	111	98	113	100
Imp.Val.-Early	Holly	100	98	117	-	112	96	96	111	93	107	105	-	-
Imp.Val.-Early	Holly	100	100	130	-	122	110	110	122	106	118	109	-	-
Imp.Val.-Early	Holly	100	100	124	-	116	105	106	118	94	112	102	-	-
Imp.Val.-Late	Holly	100	105	119	-	116	102	96	110	95	114	106	-	-
Imp.Val.-Late	Holly	100	109	131	-	117	108	105	117	96	106	112	-	-
Imp.Val.-Late	Holly	100	111	129	-	128	117	119	116	105	117	115	-	-

Sucrose percentages of bolting resistant hybrids and commercial varieties
in 1958 California variety tests expressed in percent of the sucrose percentage of US 75

Location	Testing Agency	US 75	US 56/2	US H2	663H2	787H1	US H3	F56-66H2	F57-86H1	7508H1	7615H2	7569H2	7569H3	787H2
Coastal Area														
Salinas	USDA	100	102	-	101	99	-	-	102	101	102	102	-	95
Salinas	Union	100	102	104	103	99	107	103	106	104	104	103	-	102
Alisal	Spreckels	100	103	-	-	-	-	-	101	-	-	-	-	102
Spreckels	Spreckels	100	99	-	102	-	-	-	102	106	-	95	-	99
King City	Union	100	104	104	105	101	102	107	103	107	-	110	105	96
King City	Spreckels	100	-	-	103	-	-	-	-	-	-	-	-	-
San Ardo	Union	100	105	101	103	102	106	111	104	105	-	109	105	101
Gilroy	Spreckels	100	-	-	101	-	-	-	-	-	-	-	-	-
Betteravia	Union	100	105	97	102	102	94	108	98	105	-	98	-	102
Alvarado	Holly	100	104	103	-	-	104	105	100	-	-	-	-	-
Central Valley														
Tracy	Holly	100	103	101	-	98	107	106	99	100	-	106	108	-
Ryer Island	Holly	100	100	98	-	-	-	-	-	-	-	-	-	-
Davis	U.of Calif.	100	-	104	-	102	-	-	-	-	-	106	104	-
Imperial Valley														
Brawley	USDA	100	104	101	-	99	103	-	102	-	101	101	101	101
Imp.Val.-Early	Holly	100	98	100	-	97	100	101	96	98	100	102	-	-
Imp.Val.-Early	Holly	100	101	101	-	101	104	106	102	100	105	104	-	-
Imp.Val.-Early	Holly	100	98	100	-	99	100	104	99	98	101	103	-	-
Imp.Val.-Late	Holly	100	100	100	-	101	106	104	100	103	104	103	-	-
Imp.Val.-Late	Holly	100	98	103	-	100	107	104	101	99	102	104	-	-
Imp.Val.-Late	Holly	100	102	103	-	102	109	109	101	100	104	109	-	-

VARIETY TEST, BRAWLEY, CALIFORNIA, 1956-57

Charles Price

Location: Southwestern Irrigation Field Station, Brawley, California.

Soil Type: Holtville silty clay loam.

Previous crops: 1952 Flax; 1953 Beets; 1954 Sorghum; 1955, 56 Fallow; 1957 Sugar Beets.

Fertilizer used: 16-20-0, 200 pounds per acre applied October 10, 1957; Ammonium Nitrate, 400 pounds per acre applied November 13, 1957.

Thinning: October 7, 8, & 9, 1957.

Irrigations: Seven total. First irrigation September 26, 1957.

Cultivations: Three cultivations and four hand hoeings.

Insect control: Cucumber beetles were controlled by spraying with DDT at the rate of 2 pounds per acre. Cabbage loopers were successfully controlled by spraying with DDT.

Experimental design: Randomized block with 8 replications. Varieties planted in two-row plots with rows spaced 30 inches apart. Plots 46 feet long.

Disease problems: Curly top exposure was extremely light. Virus yellows infection reached approximately 100% by harvest, but reduction in root weight was not considered to be high because of the late date at which the beets were infected. Virus yellows was not observed until March approximately two months prior to harvest. Experimental results in tests at Salinas, California, with virus yellows have shown that age of plant at time of infection has an important bearing on the amount of damage produced. The plants infected with virus yellows when young are more severely damaged from virus yellows when infected later in growth. The percent sucrose might have been lowered, however, by virus yellows even though infection came in late.

Variety Test, Brawley, California

(8 replicated plots of each variety)

Planted Sept. 19, 1957
Harvested April 14-18, 1958

Variety	Description	Acre yield: Gross sugar	Acre yield: Beets	Sucrose	T. J. App. purity	Beet count
		Pounds	Tons	Percent	Percent	Number
663H1	(MS of NB1 x NB3) x 663	10,483	31.2	16.8	93.2	149
787H1	(MS of NB1 x NB4) x 787	10,428	31.6	16.5	91.3	145
7569H3	(MS of NB1 x NB3) x 7569mm	10,140	30.0	16.9	92.4	144
F57-554H1	MS of NB1 x NB4	10,072	29.8	16.9	92.3	148
7615H2	585H0 x 7615	9,937	29.4	16.9	93.5	155
F57-86H1	(MS of NB1 x NB4) x Bolt.sel. US 35	9,860	29.0	17.0	92.8	154
F57-63	NB, CT sel. US 15 x US 22/3	9,811	29.2	16.8	93.1	149
786H2	(4547H0 x 5512) x Bolt.sel. US 35	9,326	26.8	17.4	92.9	134
581H1	(MS of NB1 x NB3) x NB,CT sel.US 35	9,322	27.1	17.2	93.2	142
787	Bolt. res. sel. US 75	9,139	27.2	16.8	91.4	143
787H2	(MS of NB5 x NB6) x 787	9,025	26.7	16.9	92.5	141
368	US 75	8,985	26.9	16.7	92.4	138
7569H2	461H0 x 7569mm	8,788	26.0	16.9	91.2	141
459	US 56/2	8,650	25.0	17.3	91.9	130
786H3	6507-3H2mm x Bolt.sel. US 35	7,946	23.1	17.2	92.5	149
7569H0	5515H0mm x 7569mm	7,466	20.4	18.3	93.0	149
General MEAN of all varieties		9,350	27.5	17.0	93.9	144
S. E. of MEAN		281.6	0.74	0.23	0.53	Per
Significant difference (19:1)		788[1]/	2.06	0.66	1.47	100'
S. E. of MEAN in % of MEAN		3.01	2.69	1.35	0.56	row

(Odds 19:1 = 1.98 $\sqrt{2}$ x Standard Error of Mean)
1/ By short-cut formula.

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES: Tons beets	Percent sucrose	Percent T.J.P.
Between varieties	15	69.91	1.37	4.12
Between replications	7	5.94	1.81	1.37
Remainder (Error)	105	4.32	0.44	2.22
Total	127			
Calculated F value		16.18**	3.11**	1.86*

* Exceeds the 5% point of significance (F = 1.77)
**Exceeds the 1% point of significance (F = 2.30)

VARIETY TEST, SALINAS, CALIFORNIA, 1958

Location: Spence Field of the U. S. Agricultural Research Station.

Soil type: Sandy loam.

Previous crops: Fallow,1957; Alfalfa,1955-56; Fallow, 1954.

Fertilizer used: 700 lbs. per acre (5-10-10) preplant broadcast.
250 lbs. per acre ammonium sulfate March 3, 1958.
275 lbs. per acre ammonium sulfate April 14, 1958.

Planting date: December 13, 1957.

Thinning date: January 30 to February 2, 1958.

Harvest date: August 13-15, 1958.

Irrigations: At 7-10 day intervals with sprinkler system.

Experimental design: Randomized block with 5 replications. Varieties planted in two-row plots with rows spaced 28 inches apart. Plots 50 feet long.

Sugar analyses: From two 10-beet samples per plot by Spreckels Sugar Company.

VARIETY TEST, SALINAS, CALIFORNIA, 1958

(5 replicated plots of each variety)

Planted December 13, 1957
Harvested August 13-15, 1958

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Virus Yellows Percent	Beet Count Number
7615H2	585H0 x 7615	13,083	44.42	14.74	2.9	154
663H2	(MS of NB5 x NB1) x 663	12,733	43.28	14.72	5.8	148
F57-86H1	(MS of NB1 x NB4) x 586	11,957	40.30	14.84	5.4	150
787H1	(MS of NB1 x NB4) x 787	11,922	41.46	14.38	8.6	156
787H2	(MS of NB5 x NB6) x 787	11,601	42.08	13.80	6.9	153
7508H1	(MS of NB1 x NB4) x 7508	11,480	39.18	14.68	10.4	156
7569H2	461H0 x 7569 mm	11,361	38.38	14.80	7.8	152
7512H3	(MS of NB1 x NB4) x NB6	11,230	40.68	13.82	5.1	158
786H2	(MS of NB5 x NB6) x 586	10,926	38.08	14.36	12.0	154
7508H3	(MS of NB5 x NB6) x 7508	10,920	39.20	13.94	14.8	146
7508H4	6507-3H2 mm x 7508	10,694	37.58	14.24	18.5	117
787	Bolt. res. sel. 368	10,556	36.90	14.32	11.7	150
368	US 75	10,548	36.36	14.52	12.9	156
786H3	6507-3H2 mm x 586	10,466	35.44	14.76	10.7	143
767	Bolt. res. sel. 368	9,986	35.38	14.12	14.0	154
459	US 56/2	9,896	33.48	14.76	12.1	155
General MEAN of all varieties		11,210	38.89	14.43	10.0	150
S. E. of MEAN		338	0.94	0.33	2.22	Per 100' row
Significant Difference (19:1)		955	2.67	N. S.	6.28	
S. E. of MEAN in % of MEAN		3.01	2.42	2.29	22.20	

(Odds 19:1 = 2.00 x $\sqrt{2 \text{ x}}$ Standard Error of MEAN)

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Pounds sugar	Tons beets	Percent sucrose	Percent yellows
Between varieties	15	4,071,823	46.16	0.64	87.04
Between replications	4	133,808	8.63	0.54	106.73
Remainder (Error)	60	569,598	4.45	0.59	24.63
Total	79				
Calculated F value		7.15**	10.37**	1.08(NS)	3.53**

** Exceeds the 1% point of significance (F = 2.36)

VARIETY TEST, DAVIS, CALIFORNIA, 1958.

R. S. Loomis

Location: Field D-2, Campbell Tract of the Agronomy Department, University of California, at Davis.

Soil type: Yolo loam.

Previous crops: 1957, fallow; 1956, soybeans; 1955-56, barley; 1955, soybeans; 1954, flax.

Fertilizer: May 17, 80 lbs. per acre ammonium nitrate sidedressed to the "low" nitrogen plots and 160 lbs. per acre to the high nitrogen plots.

Planting date: April 17, 1958.

Thinning date: May 20, 1958.

Harvest date: October 21-22, 1958.

Irrigations: April 21, May 8-9, May 26, June 18, July 3-4, July 11, July 21, and subsequently at two—week intervals

Cultivations: May 5 and June 13; weeded on July 8 and about August 15.

Insect control: Leaf miner: 12 oz/acre of Dieldrin applied June 13-14.
Army worm: 4 lbs./acre of DDT applied July 5.

Diseases: Virus yellows appeared after August 1 and the severity of symptoms increased up to harvest.

Experimental design: Randomized block with 16 replications. Varieties planted in double-row beds with 40-inch centers. Plots 60 feet long. Fifty feet of each row harvested.

Sugar analysis: From two samples per plot by Spreckels Sugar Company, Woodland, California.

Remarks: No difference was found between the high and low nitrogen series, and they were combined for analysis. One replication was excluded from the analysis because of a missing plot weight. Results analyzed by U. S. Department of Agriculture Research Station, Salinas, California.

VARIETY TEST, DAVIS, CALIFORNIA, 1958.

(15 replicated plots of each variety) By Univ. of Calif. at Davis

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
787H1	(MS of NB1 x NB4) x 787	4920	24.1	10.2	131
7569H2	461HO x 7569 mm	4465	21.1	10.6	126
7569H3	(MS of NB1 x NB3) x 7569 mm	4339	20.9	10.4	135
663H1	(MS of NB1 x NB3) x 663	4333	20.8	10.4	123
368	US 75	4020	20.1	10.0	133
General MEAN of all varieties		4415	21.4	10.3	Beets per 100' of row
S. E. of MEAN		102 1/	0.43	0.114	
Significant Difference (19:1)		288	1.23	0.32	
S. E. of MEAN in % of MEAN		2.31	2.03	1.10	

Odds 19:1 = $2\sqrt{2}$ x Standard Error of MEAN.
1/ By short cut formula.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Tons Beets	MEAN SQUARES Percent Sucrose
Between varieties	4	37.17	0.78
Between replicates	14	4.22	0.72
Remainder (Error)	56	2.82	0.19
Total	74		
Calculated F value		13.18**	4.02**

**Exceeds the 1% point of significance (F = 3.68)

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1958

First planting - September 7, 1957.

By Holly Sugar Corporation

Variety	Description	Gross sugar 1st.har.	Gross sugar 2nd.har.	Gross sugar 3rd.har.	Tons per acre 1st.har.	Tons per acre 2nd.har.	Tons per acre 3rd.har.	Sucrose 1st.har.	Sucrose 2nd.har.	Sucrose 3rd.har.	Thin juice purity 1st.har.	Thin juice purity 2nd.har.	Thin juice purity 3rd.har.
		Pounds	Pounds	Pounds	Tons	Tons	Tons	Percent	Percent	Percent	Percent	Percent	Percent
663H1	(MS of NB1 x NB3) x 663	8,084	10,021	9,061	22.30	29.41	27.78	18.13	17.04	16.31	95.29	93.54	93.31
787H1	(MS of NB1 x NB4) x 787	7,716	9,427	8,484	21.90	27.79	26.33	17.62	16.96	16.11	94.08	94.13	92.86
F57-86H1	(MS of NB1 x NB4) x 586	7,714	9,418	8,619	22.00	27.44	26.80	17.53	17.16	16.08	94.29	93.85	92.93
7615H2	585HO x 7615	7,431	9,103	8,144	20.54	25.72	24.66	18.09	17.70	16.51	95.24	93.53	92.99
663	N.B.,C.T.sel.US15 x US 22/3	7,119	8,713	8,093	19.83	25.79	25.09	17.95	16.89	16.13	94.25	94.49	92.88
7569H2	461HO x 7569 mm	7,263	8,383	7,420	19.66	23.98	22.14	18.47	17.48	16.76	93.57	93.15	92.88
F56-66H2	(MS of NB1 x NB2) x 366	6,676	8,509	7,721	18.18	23.80	22.72	18.36	17.88	16.99	94.45	93.66	93.32
F56-66H3	(MS of NB1 x NB3) x 366	6,644	8,493	7,643	18.21	24.15	23.56	18.24	17.58	16.22	95.10	94.73	93.87
Lot 7252	US 75	6,920	7,702	7,288	19.04	22.84	22.38	18.17	16.86	16.28	94.37	94.19	93.48
787H3	5515HO mm x 787	6,545	8,542	7,183	17.81	24.53	21.77	18.38	17.41	16.50	94.69	93.80	93.46
Lot 618	US 56/2	6,814	7,688	7,275	19.04	22.69	22.78	17.89	16.94	15.97	94.69	93.42	92.65
787	Bolt res. sel. US 75	6,438	8,029	7,293	18.35	24.23	22.72	17.54	16.57	16.05	94.63	93.15	92.68
F57-79	Price's sel. US 75	6,766	7,863	6,992	18.85	23.33	21.44	17.95	16.85	16.31	95.04	93.70	92.59
7508H1	(MS of NB1 x NB4) x 7508	6,414	8,126	6,883	18.03	24.17	21.64	17.79	16.81	15.90	94.48	93.72	92.66
General MEAN of all varieties in test		7,233	8,782	7,898	20.16	25.57	24.25	17.95	17.17	16.29	94.51	93.83	93.07
S. E. of MEAN		210	277	220	0.53	0.77	.63	0.21	0.15	0.16	0.39	0.34	0.35
Significant Difference (19:1)		588	775	613	1.49	2.16	1.76	0.60	0.43	0.46	NS	NS	NS
S. E. of MEAN in % of MEAN		2.91	3.16	2.78	2.65	3.03	2.59	1.19	0.90	1.00	0.41	0.36	0.37

Cooperator: Jack Brothers and McBurney.

Design: 4x5 Rectangular Lattice (Randomized Block Analysis).

Plot size: Single row plots 54 feet x 34 inches. 50 ft. of row harvested.

Harvest dates: April 19, 1958, May 26, 1958, July 3, 1958.

Results extracted from test of 20 varieties.

Beet Seed Breeding Department
Holly Sugar Corporation

VARIETY TEST, IMPERIAL VALLEY, CALIFORNIA, 1958.

2nd planting - October 9, 1957.

By Holly Sugar Corporation

Variety	Description	Gross Sugar			Tons Per Acre			Sucrose			Thin Juice Purity	
		1st.har.	2nd.har.	3rd.har.	1st.har.	2nd.har.	3rd.har.	1st.har.	2nd.har.	3rd.har.	2nd.har.	3rd.har.
		Pounds	Pounds	Pounds	Tons	Tons	Tons	Percent	Percent	Percent	Percent	Percent
663H1	(MS of NB1 x NB3) x 663	5,563	9,198	8,419	19.33	28.15	27.42	14.39	16.34	15.35	92.94	91.78
787H1	(MS of NB1 x NB4) x 787	5,419	8,190	8,328	18.77	26.03	27.27	14.44	15.73	15.27	92.03	90.65
663	N.B.,C.T.sel.US 15 x US 22/3	5,356	7,908	8,206	19.59	25.69	27.51	13.67	15.39	14.91	92.03	91.15
F57-86H1	(MS of NB1 x NB4) x 586	5,152	8,210	7,571	18.10	25.85	25.04	14.34	15.88	15.12	92.35	91.73
7615H2	585HO x 7615	5,336	7,420	7,628	17.94	23.11	24.43	14.87	16.05	15.61	92.67	91.55
787H3	5515HO mm x 787	4,971	7,438	7,965	16.73	22.12	24.86	14.86	16.81	16.02	91.93	90.77
7569H2	461HO x 7569 mm	4,954	7,818	7,495	16.73	23.84	22.96	14.81	16.40	16.32	91.61	90.62
Lot 618	US 56/2	4,918	7,609	7,226	17.15	24.45	23.60	14.34	15.56	15.31	91.99	91.73
F56-66H3	(MS of NB1 x NB3) x 366	4,765	7,536	7,643	15.72	22.20	22.83	15.16	16.97	16.29	92.81	91.99
F57-79	Price's sel. US 75	4,707	7,056	7,146	17.02	22.09	23.65	13.83	15.97	15.11	91.87	91.19
F56-66H2	(MS of NB1 x NB2)x 366	4,518	7,369	7,760	15.16	22.38	23.69	14.90	16.46	16.38	91.88	92.44
Lot 7252	US 75	4,690	6,999	6,513	16.35	22.15	21.75	14.34	15.80	14.97	91.92	90.87
7508H1	(MS of NB1 x NB4) x 7508	4,478	6,749	6,832	15.17	21.55	22.79	14.76	15.66	14.99	92.42	91.12
787	Bolt. res. sel. US 75	4,270	6,676	6,540	15.73	21.43	21.62	13.57	15.58	15.13	92.05	91.55
General MEAN of all varieties in test		5,116	7,805	7,662	17.69	24.31	24.76	14.47	16.05	15.48	92.31	91.39
S. E. of MEAN		178	202	267	0.51	0.58	0.81	0.28	0.17	0.19	0.33	0.52
Significant Difference (19:1)		496	564	747	1.43	1.61	2.26	0.78	0.47	0.52	NS	NS
S. E. Of MEAN in % of MEAN		3.47	2.59	3.49	2.89	2.36	3.27	1.92	1.06	1.22	0.35	0.57

Cooperator: Jack Brothers and McBurney.

Design: 4 x 5 Rectangular lattice (Randomized Block Analysis).

Plot size: Single row plots 54 feet x 34 inches. 50 feet of row harvested.

Harvest dates: April 19, 1958, May 26, 1958, June 30, 1958.

Results extracted from test of 20 varieties.

Beet Seed Breeding Department
Holly Sugar Corporation

CTR Variety Test 1958 Alvarado, Calif.
Coop: F. A. Wilcox Co.

Variety	Source	Gross Sugar	% T.J.P.	Tons Per Acre	% Sucrose	No. Beets 100' Row
F56-66H2	(NB1 x NB2) x C366	6655	94.02	21.648	15.37	236
C663H1	(NB1 x NB3) x C663	6599	93.63	21.880	15.08	265
F57-86H1	(NB1 x NB4) x C586	6473	93.58	22.214	14.57	250
F57-63	L 7341 C663	6187	92.62	21.364	14.48	246
US 75	L 7252	6006	93.78	20.553	14.61	276
F57-79	L 7250	5996	93.68	20.689	14.49	277
US 56/2	L 7340	5745	93.48	18.937	15.17	266
F56-66H3	(NB1 x NB3) x C366	5480	94.10	18.073	15.16	247
Gen Mean		6347 A/	93.76	21.442	14.81	255
SE mean		232	.35	.673	.28	
LSD (5%)		649	.99	1.883	NS	
SEm/Gen mean (%)		3.65	.38	3.14	1.87	

VARIANCE TABLE

Variation Due To	D F	Mean Squares Tons Per Acre	% T.J.P.	Percent Sucrose
Variety	15	25.105	2.477	.885
Rep	8	24.781	3.840	1.607
Error	120	4.075	1.117	.694
Total	143	7.439	1.412	.765
Calc. F		6.16**	2.22**	1.28 NS

** Exceeds 1% point 2.19
A/ Short Cut Formula

Design: 4 x 4 Triple Lattice (Randomized Block Analysis)
Plots : 2 rows (28") x 53' planted; 2 rows x 50' harvested
Planted: 1-23-58 Harvested: 9-20-58

Results extracted from a test of 16 varieties

CTR Variety Test | 1958 | Tracy, Calif.
Coop: John Paulson

Variety	Source	Gross Sugar	% T.J.P.	Tons Per Acre	% Sucrose	No. Beets 100'Row
C7569H2	C461HO x C7569 mm	8167	89.98	25.780	15.84	159
C767H1	(NB1MS x NB4) x C767	8002	89.92	27.256	14.68	172
US 22/3	L 513	7985	89.80	26.996	14.79	164
C787H1	(NB1MS x NB4) x C787	7878	90.30	27.393	14.38	166
F57-86H1	(NB1MS x NB4) x C586	7786	90.12	26.232	14.84	167
C663H1	(NB1MS x NB3) x C663	7784	90.54	25.792	15.09	173
F57-63	L 7341 C663	7735	89.63	27.044	14.30	159
C7569H3	(NB1MS x NB3) x 7569 mm	7563	90.45	23.561	16.05	151
F56-66H2	(NB1MS x NB2) x C366	7640	89.84	24.224	15.77	156
US 75	L 7252 (C768)	7541	89.45	25.255	14.93	169
F57-79	L 7250	7443	90.44	24.992	14.89	177
C787	NB Sel US 75	7404	89.69	25.691	14.41	166
US 35/2	L 405	7261	90.24	23.036	15.76	178
F56-66H3	(NB1MS x NB3) x C366	7203	91.20	22.636	15.91	161
C7508H1	(NB1MS x NB4) x 7508	7031	90.04	23.656	14.86	170
US 56/2	L 7340	6861	89.51	22.391	15.32	172
Gen Mean		7650	90.12	25.273	15.15	165
SEm		186 A/	1.55	.499	.21	
LSD (5%)		516	NS	1.386	.59	
SEm/Gen Mean		2.42	.46	1.97	1.41	

VARIANCE TABLE

Source of Variation	D F	Mean Squares: Tons Per Acre	% T.J.P.	Percent Sucrose
Variety	41	17.109	2.126	2.684
Rep	8	76.288	85.613	8.821
Error	328	2.239	1.547	.410
Total	377	5.427	3.394	.836
Calc. F		7.64**	1.37 NS	6.54**

** Exceeds 1% Point 1.64
A/ Short Cut Formula

Design: 6 x 7 Triple Rectangular Lattice (Randomized Block Analysis)
Plot Size: 2 rows (30") x 53' Planted; 2 rows x 50' Harvested
Planted: May 24, 1958 Harvested: October 29, 1958

Results extracted from a test of 42 varieties

Variety Test - NB-CTR 1958 Ryer Island, Calif.
Coop: Jongeneel & Hechtman

Variety	Source	Gross Sugar	% T.J.P.	Tons Per Acre	% Sucrose	No. Beets 100' Row
663H1	(NB1MS x NB3) x C663	8040	92.24	25.109	16.01	151
US 75	L 7252	8025	91.93	24.677	16.26	165
F57-63	L 7341	7901	91.52	24.816	15.92	139
US 56/2	L 7340	7390	92.19	22.754	16.24	157
F57-79	L 7250	7041	92.21	21.559	16.33	149
Mean of Test		7844	91.92	24.570	15.97	155
SE mean		247 A/	.52	.706	.20	
LSD (5%)		699	NS	2.002	.58	
SEm/Gen Mean (%)		3.14	.57	2.88	1.27	

VARIANCE TABLE

Variation Due To	D F	Tons Beets	% T.J.P.	% Sucrose
Variety	8	32.878	1.180	.896
Rep	8	16.986	3.544	.555
Column	8	9.551	2.533	.803
Error	56	4.491	2.412	.371
Total	80	9.085	2.414	.485
Calc. F		7.32**	.49 NS	2.42*

* Exceeds 5% point 2.11
** Exceeds 1% point 2.85
A/ Short Cut Formula

Design: 9 x 9 Latin Square
Plot Size: 2 rows (22") x 53' planted; 2 rows x 50' harvested
Planted: March 10, 1958 Harvested: September 15, 1958
2 15-20 beet samples per plot for sucrose and purity determination

Results extracted from a test of 9 varieties

Variety Test 1958 Tulare, Calif.
NB-CTR Fall Planted Coop: Ed Irwin

Variety	Source	Gross Sugar	% T.J.P.	Tons Per Acre	% Sucrose	No. Beets 100' Row
C7508H1	(NB1MS x NB4) x C7508	8485	88.79	31.612	13.42	202
F56-86H1	(NB1MS x NB4) x C586	8422	87.62	32.342	13.02	217
C787H1	(NB1MS x NB4) x C787	8377	87.35	35.436	11.82	205
C663H2	(C4547HO x NB1) x C663	8116	87.76	31.407	12.92	220
C7569H2	(C461HO x 7569mm)	7963	87.33	29.980	13.28	211
C787H2	(C4547HO x 5512) x C787	7903	84.91	33.888	11.66	204
F57-79	L 7356 C379	6909	87.43	26.841	12.87	196
F57-79	L 7250 C579	6490	86.57	24.925	13.02	194
US 75	L 7252 C468	6472	86.66	28.236	11.46	183
US 75	L 7317 C368	6362	85.91	26.334	12.08	190
C787	NB US 75	5684	87.26	23.922	11.88	188
Gen Mean		7474	87.39	30.019	12.51	201
SE mean		744 A/	1.04	1.618	.57	
LSD (5%)		1548	NS	4.759	NS	
SE mean/Gen Mean		7.04	1.19	5.39	4.53	

VARIANCE TABLE

Source of Variation	D F	Mean Squares Tons Beets	% Thin Juice Purity	% Sucrose
Reps	2	5.253	16.350	5.604
Var (Ignor. Block)	15	35.549	5.265	1.061
Error	30	14.035	3.872	.786
Error (Intra Block)	21	4.133	2.748	.450
Block (Elim Var)	9	37.140	6.497	1.570
Var (Elim. Block)	15	35.744	3.529	.865
Total	47	20.528	4.848	1.079
Calc. F		8.65**	1.26 NS	1.92 NS

** Exceeds 1% Point 3.03
A/ Short Cut Formula

Design: 4 x 4 Triple Lattice 3 replications
Plot Size: 2 rows (30") x 54' Planted; 2 rows x 50' Harvested
Planted: October 17, 1957 Harvested:

Results extracted from a test of 16 varieties

Remarks: Only three of nine reps harvested. Results therefor not too reliable. All or portions of other reps lost to rot or from drouth in sand spots.

Variety Test
CTR-Spring Planted

1958

Tulare, Calif.
Coop: Lester Travis

Variety	Source	Gross Sugar	% T.J.P.	Tons Per Acre	% Sucrose	No. Beets 100'Row
US 22/3	L 513	5897	84.82	27.404	10.76	174
F57-86H1	(NB1MS x NB4) x C586	5841	86.78	25.756	11.34	183
F57-63	L 7341	5753	85.72	26.391	10.90	177
C663H1	(NB1MS x NB3) x C663	5730	88.38	25.812	11.10	188
C7569H2	C461H0 x C7569	5355	86.88	22.866	11.71	192
F56-66H2	(NB1 x NB2) x C366	5230	85.94	21.902	11.94	160
C7569H3	(NB1MS x NB3) x C7569	4972	87.67	21.375	11.63	199
US 35/2	L 405	4899	85.76	20.866	11.74	183
C787H2	(NB5MS x NB6) x C787	4845	84.96	22.812	10.62	193
US 56/2	L 7340	4517	86.00	20.385	11.08	175
C7508H1	(NB1MS x NB4) x C7508	4442	85.88	21.752	10.21	197
C787H1	(NB1MS x NB4) x C787	4365	86.08	19.505	11.19	182
US 75	L 7252	4224	84.66	19.961	10.58	171
F57-79	L 7250	4217	84.64	20.354	10.36	168
C787	NB US 75	3799	85.12	19.461	9.76	186
Gen Mean		5146	86.33	23.222	11.07	185
SE mean		619 A/	1.68	2.675	.34	
LSD (5%)		1777	NS	NS	1.10	
SEm/Gen Mean (%)		12.03	1.68	12.14	3.48	

VARIANCE TABLE

Source of Variation	DF	Mean Squares: Tons Beets	% Thin Juice Purity	% Sucrose
Rep	2	56.696	2.695	1.161
Var (Ignor. Block)	24	35.314	7.937	1.160
Error	48	25.760	6.255	.464
Error (Intra Block)	36	18.637	6.042	.409
Blocks (Elim. Var)	12	47.127	6.896	.630
Var (Elim. Blocks)	24	19.722	7.405	1.51
Total	74	29.694	6.705	.708
Calc. F		1.06 NS	1.23 NS	2.82**

** Exceeds 1% point 2.02
A/ Short cut formula

Design: 5 x 5 Triple Lattice - 9 reps.
Plot Size: 2 rows (30") x 53' planted; 2 rows x 50' harvested
Planted: March 5, 1958 (Rain 3-6-58) Harvested October 24, 1958

Remarks: Only three of nine reps harvested. Results therefor not too reliable. All or portions of other reps lost to rot or from drouth in sand spots.

Results extracted from a test of 25 varieties

Results with U. S. Varieties Included in Spreckels Sugar Company Tests in the Salinas, California District

(Data furnished by Spreckels Sugar Company)

Variety	King City Planted 1/23/58 Harvested 11/11/58			Alisal Planted 12/2/57 Harvested 8/22/58			Gilroy Planted 1/22/58 Harvested 9/11/58			Spreckels Planted 12/11/57 Harvested 8/26/58		
	Acre Yield			Acre Yield			Acre Yield			Acre Yield		
	Sugar Pounds	Beets Tons	Sucrose Percent	Sugar Pounds	Beets Tons	Sucrose Percent	Sugar Pounds	Beets Tons	Sucrose Percent	Sugar Pounds	Beets Tons	Sucrose Percent
663H2	8,900	35.59	12.5	-	-	-	7,180	25.23	14.2	7,580	29.67	12.8
F57-86H1	-	-	-	9,820	31.74	15.5	-	-	-	7,350	28.63	12.8
787H2	-	-	-	9,840	31.35	15.7	-	-	-	6,810	27.25	12.5
7508H1	-	-	-	-	-	-	-	-	-	7,860	29.66	13.3
US 75	8,020	33.32	12.1	9,340	30.26	15.4	6,920	24.69	14.0	6,650	26.14	12.6
US 56/2	-	-	-	9,180	28.99	15.9	-	-	--	5,720	22.95	12.5
7569H2	-	-	-	-	-	-	-	-	-	6,080	25.37	12.0
General Mean	8,920	36.77	12.1	9,580	30.83	15.5	6,900	24.52	14.1	6,440	26.68	12.0
S. E. Of Mean	274	0.956	0.240	312	0.994	0.136	368	1.376	0.109	264	0.903	0.266
Sig. diff. (19:1)	774	2.70	0.68	NS	NS	0.53	1,040	3.89	0.31	730	2.52	0.74
S. E. of Mean in % of Mean	3.07	2.60	1.98	3.25	3.22	1.20	5.61	5.61	0.78	4.09	3.38	2.21

663H2 = (MS of NB5 x NB1) x 663
F57-86H1 = (MS of NB1 x NB4) x Bolt. res. US 35/2
787H2 = ($\overline{\text{MS}}$ of NB1 x NB4) x Bolt. res. US 75
7508H1 = (MS of NB1 x NB4) x 7508 inbred
7569H2 = 461HO x 7569mm

Results with U. S. Varieties Included in Spreckels Sugar Company Tests in the San Joaquin Valley District.

(Data furnished by Spreckels Sugar Co.)

Arvin test - Planted February 21, 1958. Harvested November 12, 1958.

Variety	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beet Count Number
663H1	5,094	25.59	10.15	160
US 75	4,132	19.81	10.46	168
General Mean	4,358	21.63	10.20	167
S. E Of Mean	0.15	1.26	0.225	
Sig. diff. (19:1)	NS	3.60	NS	Beets
S. E. of Mean in % of Mean	6.88	5.82	2.21	per 100' of row

Leaf spot was a factor in the Arvin test. The field was sprinkle irrigated and severe defoliation occurred.

Newman test - Planted April 23, 1958. Harvested October 14, 1958.

Variety	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Beet Count Number
663H1	4,770	14.56	16.37	111
US 22/3	4,704	14.23	16.68	126
US 75	4,240	13.12	16.18	127
General Mean	4,670	14.36	16.77	121
S. E. of Mean	0.124	1.35	0.49	Beets
Sig. diff. (19:1)	NS	NS	NS	per 100'
S. E. of Mean in % of Mean	5.18	9.40	2.92	of row

VARIETY TEST, SALINAS, CALIFORNIA, 1958.

By Union Sugar Division

Location: C. C. Salmina Ranch, Salinas, California.

Soil type: Adobe clay.

Previous crops: Lettuce, 1957; barley-vetch, green manure, and lettuce, 1956; celery, 1955; sugar beets, 1954.

Fertilizer used: Preplant none.
500 lbs. per acre ammonium sulfate, May 20, 1958.

Planting date: March 6, 1957.

Thinning date: April 25, 1958.

Harvest date: October 7, 1958.

Irrigations: Two, the second on July 14, 1958.

Diseases and insects: Virus yellows averaged 26 percent in the test plot. Insect damage was not a factor in this test.

Experimental design: Randomized block with eight replications and randomized block with four replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Remarks: Seed was furnished, test designed, and results analyzed by U. S. Department of Agriculture Research Station, Salinas, California.

VARIETY TEST, SALINAS, CALIFORNIA, 1958

(8 replicated plots of each variety) By Union Sugar Division

Variety	Description	Acre Yield		Sucrose	Thin Juice purity	Virus yellows	Harvest Count
		Sugar	Beets				
		Pounds	Tons	Percent	Percent	Percent	Number
7615H2	585HO x 7615	11,606	34.2	16.4	90.0	19.8	148
663H2	MS of NB5 x NB1 x 663	10,891	34.0	16.1	90.1	26.3	151
F57-86H1	(MS of NB1 x NB4) x 586	10,857	32.7	16.6	89.8	23.1	151
787H1	(MS of NB1 x NB4) x 787	10,625	34.2	15.6	89.4	21.3	148
581H2	(MS of NB1 x NB2) x 581	10,308	31.8	16.2	89.7	21.6	141
7512H3	(MS of NB1 x NB4) x 7512	10,249	33.0	15.6	89.8	15.0	145
7508H1	(MS of NB1 x NB4) x 7508	10,228	31.1	16.4	89.3	26.0	150
7569H2	461HO x 7569	10,120	31.2	16.2	89.3	34.7	149
787H2	(MS of NB5 x NB6) x 787	9,960	31.3	16.0	90.0	30.7	151
787	Bolt. res. sel. US 75	9,794	31.3	15.7	89.6	33.1	140
368	US 75	9,625	30.7	15.7	89.1	30.4	145
459	US 56/2	9,070	28.4	16.0	89.4	33.6	140
General MEAN of all varieties		10,278	32.0	16.0	89.6	26.3	Beets per 100' of row
S. E. of MEAN		231.7	1.20	0.21	0.34	2.40	
Significant Difference (19:1)		652	3.39	0.59	NS	6.74	
S. E. of MEAN in % of MEAN		2.25	3.76	1.32	1.06	9.12	

Odds 19:1 = 1.99 $\sqrt{2}$ x Standard Error of Mean.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES				
		Gross Sugar	Tons Beets	Percent Sucrose	Percent Purity	Percent virus yellows
Between varieties	11	3,522,890	23.66	1.00	0.89	315.41
Between replications	7	1,945,540	38.95	5.71	9.68	121.27
Remainder (Error)	77	429,332	11.61	0.36	0.92	45.98
Total	95					
Calculated F value		8.21**	2.04*	2.82*	NS	6.86**

* Exceeds the 5% point of significance (F = 1.91)
**Exceeds the 1% point of significance (F = 2.48)

VARIETY TEST, SALINAS, CALIFORNIA, 1958

(4 replicated plots of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Thin juice purity Percent	Virus Yellows Percent	Harvest Count Number
F57-554H1	MS of NB1 x NB4	12,699	39.9	15.9	88.7	9.3	141
663H1	(MS of NB1 x NB3) x 663	11,024	35.8	15.4	88.5	12.0	133
7508H3	(MS of NB6 x NB5) x 7508	10,745	33.7	16.0	88.5	22.1	133
368	US 75	10,159	34.3	14.8	87.5	22.1	131
786H2	(MS of NB6 x NB5)x 586	10,118	31.6	16.0	88.8	20.5	133
7508H4	6507-3H2 x 7508	10,045	31.6	15.9	87.0	26.2	129
767	Bolt. res. sel. US 75	9,833	33.0	15.0	88.3	26.0	132
581H1	(MS of NB1 x NB3) x 581	9,404	29.6	15.9	88.5	18.4	120
7547H1	5512H0 x 7547	9,224	29.4	15.7	87.8	25.1	127
786H3	6507-3H2 x 586	8,948	28.3	15.8	88.0	28.1	132
7508H2	6504-15H0 x 7508	8,675	27.5	15.8	87.4	30.2	110
7569H0	5515H0 x 7569mm	8,537	25.5	16.7	87.7	16.9	121
General MEAN of all varieties		9,951	31.7	15.7	88.1	21.4	Beets per 100' of row
S. E. of MEAN		355.2	1.75	0.30	0.38	3.46	
Significant Difference (19:1)		1,024	5.05	0.86	1.09	9.99	
S. E. of MEAN in % of MEAN		3.57	5.53	1.89	0.43	16.2	

Odds 19:1 = 2.039 x $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose	Percent Purity	Percent virus yellows
Between varieties	11	5,416,101	63.14	1.02	1.29	162.62
Between replications	3	1,200,316	7.86	2.36	1.54	145.07
Remainder (Error)	31[1/]	504,732	12.27	0.35	0.57	47.94
Total	45[1/]	10.73**	5.15**	2.88**	2.26*	3.39**

* Exceeds the 5% point of significance (F = 2.11)
**Exceeds the 1% point of significance (F = 2.88)
[1/] Two degrees of freedom subtracted for missing plot calculations.

VARIETY TEST, KING CITY, CALIFORNIA, 1958

By Union Sugar Division

Grower: A. S. Duarte.

Location: King City, California.

Soil type: Salinas clay.

Previous crops: Lettuce 1957; lettuce 1956; carrots 1955.

Fertilizer used: 400 lbs. 12:15:0 preplant.
400 lbs. ammonium sulfate.
350 lbs. ammonium sulfate.

Planting date: March 3, 1958.

Thinning date: April 24, 1958.

Harvest date: October 27, 1958.

Irrigations: Six.

Diseases and insects: Heavy infestations of nematode caused rather severe damage in some plots of the test. Virus yellows infection fairly heavy throughout test plot.

Experimental design: Randomized block with eight replications and randomized block with four replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples by Union Sugar, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by U. S. Department of Agriculture Research Station, Salinas, California.

VARIETY TEST, KING CITY, CALIFORNIA, 1958.

(8 replicated plots of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
787H1	(MS of NB1 x NB4) x 787	7969	26.6	15.0	159
663H1	(MS of NB1 x NB3) x 663	7806	25.2	15.5	151
663H2	(MS of NB5 x NB1) x 663	7464	23.9	15.7	158
7569H3	(MS of NB1 x NB3) x 7569mm	7382	23.7	15.6	147
7508H1	(MS of NB1 x NB4) x 7508	7353	23.0	16.0	147
F57-86H1	(MS of NB1 x NB4) x 586	7302	23.7	15.4	159
787H2	(MS of NB5 x NB6) x 787	7164	25.1	14.3	143
F56-66H2	(MS of NB1 x NB2) x 366	7113	22.3	15.9	137
786H5	(MS of NB1 x NB3) x 586	6803	22.4	15.2	153
459	US 56/2	6629	21.4	15.5	125
368	US 75	6540	21.9	14.9	150
787	Bolt. res. sel. 368	6455	22.3	14.5	151
General MEAN of all varieties		7165	23.5	15.3	Beets
S. E. of MEAN		285.34	0.77	0.32	per
Significant Difference (19:1)		802.94	2.15	0.89	100'
S. E. of MEAN in % of MEAN		3.98	3.28	5.82	row

(Odds 19:1 = $1.990\sqrt{2}$ x Standard Error of MEAN)

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	11	1,863,450.42	19.08	2.25
Between replicates	7	6,788,112.52	78.46	0.68
Remainder (Error)	77	651,342.87	4.69	0.79
Total	95			
Calculated F value		2.86**	4.06**	2.83**

**Exceeds the 1% point of significance (F=2.48)

VARIETY TEST, KING CITY, CALIFORNIA, 1958.

(4 replicated plots of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
F57-554H1	MS of NB1 x NB4	7644	24.8	15.4	123
7569H2	461HO x 7569	6502	20.2	16.1	137
786H3	6507-3H2 x 586	6336	19.2	16.5	153
7508H3	(MS of NB5 x NB6) x 7508	5983	20.2	14.8	122
368	US 75	5954	20.3	14.7	146
786H2	(MS of NB5 x NB6) x 586	5432	18.1	15.0	149
General MEAN of all varieties		6308	20.4	15.4	Beets
S. E. of MEAN		289.42	0.81	0.39	per
Significant difference (19:1)		872.09	2.44	1.19	100'
S. E. of MEAN in % of MEAN		4.59	3.92	2.56	of row

Odds 19:1 = 2.131 x$\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross Sugar	MEAN SQUARES Tons Beets	MEAN SQUARES Percent Sucrose
Between varieties	5	2,255,579.	20.58	2.23
Between replications	3	3,067,585.	17.83	2.57
Remainder (Error)	15	335,062.	2.63	0.62
Total	23			
Calculated F value		6.73**	7.83**	3.59*

*Exceeds the 5% point of significance (F = 2.90)

**Exceeds the 1% point of significance (F = 4.56)

VARIETY TEST, SAN ARDO, CALIFORNIA, 1958

By Union Sugar Division

Growers: Salaberry and Gudici.

Location: San Ardo, California.

Soil type: Docas clay loam.

Previous crops: Beans 1957; onions 1956; sugar beets 1955.

Fertilizer used: Preplant none.
Sidedress 400 lbs. per acre 16-20-0.
400 lbs. per acre ammonium sulfate.

Planting date: March 10, 1958.

Thinning date: April 27, 1958.

Harvest date: October 7, 1958.

Irrigations: Six.

Diseases and insects: An infection of crown rot injured plants and reduced stand in a few plots of the test. Some damage also occurred from a heavy infestation of mites in August and September. Virus yellows infection fairly heavy from midseason on.

Experimental design: Randomized block with eight replications and randomized block with four replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by U. S. Department of Agriculture Research Station, Salinas, California.

VARIETY TEST, SAN ARDO, CALIFORNIA, 1958

(8 replicated plots of each variety)

By Union Sugar Division
GROWERS: Salaberry & Guidici.

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Thin Juice Purity Percent	Harvest Count Number
787H1	(MS of NB1 x NB4) x 787	8,607	27.9	15.5	87.8	167
F57-86H1	(MS of NB1 x NB4) x 586	8,477	27.0	15.8	87.3	167
7569H3	(MS of NB1 x NB3) x 7569mm	8,146	25.6	15.9	88.2	174
F56-66H2	(MS of NB1 x NB2) x 366	8,080	23.9	16.8	88.8	166
663H2	(MS of NB5 x NB1) x 663	8,049	25.8	15.7	87.9	168
663H1	(MS of NB1 x NB3) x 663	8,020	26.3	15.3	87.9	166
7508H1	(MS of NB1 x NB4) x 7508	7,903	25.0	16.0	88.1	163
787H2	(MS of NB5 x NB6) x 787	7,901	25.8	15.4	88.2	165
786H5	(MS of NB1 x NB3) x 586	7,452	23.2	16.1	88.5	165
459	US 56/2	7,331	23.1	15.9	88.2	162
787	Bolt. res. sel. 368	7,300	23.9	15.3	87.2	162
368	US 75	6,861	22.6	15.2	86.7	161
General MEAN of all varieties		7,844	25.0	15.7	87.9	Beets
S. E. of MEAN		228.22	0.78	0.31	0.60	per
Significant Difference (19:1)		642.22	2.21	0.88	N.S.	100'
S. E. of MEAN in % of MEAN		2.91	3.12	1.97	6.86	row

Odds 19:1 = 1.990 $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose	Percent T.J.P.
Between varieties	11	2,101,772.69	22.21	1.50	2.73
Between replicates	7	1,612,174.59	16.94	14.93	17.71
Remainder (Error)	77	416,686.52	4.91	0.78	2.91
Total	95				
Calculated F value		5.04**	4.52**	1.92*	0.94(NS)

*Exceeds the 5% point of significance (F = 1.91)
**Exceeds the 1% point of significance (F = 2.48)

VARIETY TEST, SAN ARDO, CALIFORNIA, 1958.

(4 replicated plots of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	T. J. Purity	Harvest Count
		Pounds	Tons	Percent	Percent	Number
F57-554H1	(MS of NB1 x NB4)	9,709	29.0	16.8	89.8	182
7569H2	461HO x 7569 mm	8,024	22.4	18.0	88.4	162
7508H3	(MS of NB5 x NB6) x 7508	7,851	23.1	17.1	90.5	168
786H3	6507-3H2 x 586	7,389	20.8	17.8	89.5	166
786H2	(MS of NB5 x NB6) x 586	7,376	21.5	17.2	88.8	169
368	US 75	6,798	20.7	16.5	89.3	151
General MEAN of all varieties		7,858	22.9	17.2	89.4	Beets
S. E. of MEAN		369	1.03	0.30	0.80	per
Significant difference (19:1)		1,113	3.17	0.89	N.S.	100'
S. E. of MEAN in % of MEAN		4.70	4.52	1.72	0.89	of row

Odds 19:1 = 2.13 $\sqrt{2}$ x Standard Error of MEAN.

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES Gross Sugar	Tons Beets	Percent Sucrose	Percent T. J. P.
Between varieties	5	4,022,951	38.94	1.24	2.09
Between replicates	3	1,069,771	27.66	3.43	4.19
Remainder (Error)	15	545,889	4.28	0.35	2.54
Total	23				
Calculated F value		7.37**	9.10**	3.54*	0.83(NS)

* Exceeds the 5% point of significance (F = 2.90)
** Exceeds the 1% point of significance (F = 4.56)

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1958.

Location: Pizzoni Ranch, Guadalupe, California.

Soil type: Yolo Sandy Loam.

Previous crops: Beans, 1955, 1956 and 1957.

Fertilizer used: 600 lbs. ammonium sulfate per acre prior to thinning.
600 lbs. ammonium sulfate per acre in May.

Planting date: January 23, 1958.

Thinning date: March 13, 1958.

Harvest date: October 27-28, 1958.

Irrigations: Five, beginning in June through late August.

Diseases and insects: Downy mildew infection fairly heavy early in season. Stand reduction and plant injury severe in hybrids which included NB3 in the parentage. Some virus yellows infection also occurred this year. Insects were not a factor in this test.

Experimental design: Randomized block with five replications. Varieties planted on double-row beds with 40-inch centers. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by U. S. Department of Agriculture Research Station, Salinas, California.

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1958

(5 replicated plots of each variety) By Union Sugar Division

Variety	Description	Acre Yield Sugar Pounds	Acre Yield Beets Tons	Sucrose Percent	Harvest Count Number
787H1	(MS of NB1 x NB4) x 787	8702	32.5	13.3	153
663H2	(MS of NB5 x NB1) x 663	8699	32.8	13.2	156
7508H1	(MS of NB1 x NB4) x 7508	8218	30.2	13.6	158
581H2	(MS of NB1 x NB2) x 581	8097	28.8	14.1	142
787H2	(MS of NB5 x NB6) x 787	7885	29.7	13.2	137
F57-86H1	(MS of NB1 x NB4) x 586	7839	31.0	12.7	147
787	Bolt. res. sel. 368	7510	28.7	13.1	138
7569H2	461H0 x 7569 mm	7294	28.7	12.7	139
459	US 56/2	6997	25.5	13.7	149
663H1	(MS of NB1 x NB3) x 663	6912	27.5	12.6	137
368	US 75	6836	26.2	13.0	153
581H1	(MS of NB1 x NB3) x 581	5793	23.6	12.2	130
General MEAN of all varieties		7565	28.8	13.1	Beets
S. E. of MEAN		432.62	1.25	0.40	per
Significant difference (19:1)		1232.10	3.55	1.14	100'
S. E. of MEAN in % of MEAN		5.72	4.33	3.05	of row

Odds 19:1 = 2.014 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of freedom	MEAN SQUARES Gross sugar	Tons Beets	Percent Sucrose
Between varieties	11	3,619,050.78	38.31	1.45
Between replicates	4	3,947,959.36	51.64	.29
Remainder (Error)	44	935,796.34	7.77	.80
Total	59			
Calculated F value		3.87**	4.93**	N. S.

** Exceeds the 1% point of significance (F = 2.68)

Effect of Gibberellic Acid on Bolting

I. O. Skoyen

Introduction

Experiments were continued in 1958 to evaluate the effectiveness of gibberellic acid in stimulating bolting of the sugar beet. Tests were made in September and November field plantings with four bolting resistant inbreds and with F_1 hybrids involving these inbreds. A test was also conducted in the greenhouse and coldroom with two bolting resistant inbreds, to determine the effectiveness of gibberellic acid in reducing thermal-induction requirements under controlled conditions.

Materials and Procedures

Tests made in a September 17, 1957 planting were divided into an early series of applications of gibberellic acid started on January 21, 1958, and a late series started on March 7, 1958. One, three, and five applications of gibberellic acid were applied in each series at concentrations of 1000 and 2000 ppm. Four bolting-resistant inbreds and their F_1 hybrids were included in the tests. The plots each contained six to seven equally spaced plants and were not replicated.

The tests made in a November 15, 1957 planting included two, three, five, and six applications of a 1500 ppm gibberellic acid solution applied at intervals of a week to ten days for the first two applications and at two-week intervals for the remaining applications. Applications were started on February 20, 1958, in this test.

Tests were made with four inbreds and one F_1 hybrid. The plots were four feet long and were replicated two times.

For the controlled experiment conducted in the greenhouse and coldroom, plants of the 5502 and 7512 inbreds were grown in a soil culture in aluminum bands in the greenhouse until they were six weeks old. They were then given continuous coldroom treatments of five, eight, and eleven weeks at a temperature of 42° F. Continuous fluorescent and incandescent lighting was provided during the period the plants were in the coldroom. Planting dates for the plants used in these tests were staggered in a manner permitting each of the cold room treatments to be completed at approximately the same time. Plants given five and eleven weeks cold treatment were transferred to an unheated greenhouse on March 18, 1958; and those given eight weeks, on March 24, 1958. Gibberellic acid treatment was started on March 21 and March 26, respectively, using concentrations of 1000 and 3000 ppm. The number of applications ranged from one to four. The interval between applications was one to two weeks, except for the last application which was extended to four weeks to permit a more complete evaluation of the effect of the earlier applications on bolting. Supplementary light was furnished in the greenhouse for ten hours each night.

The sodium salt of gibberellic acid was used as the acid source in all tests. Aqueous solutions of the desired concentrations were prepared to which a few drops of a detergent were added as a wetting agent. The gibberellic acid solution was applied as a spray, ranging from sufficient, to thoroughly wet the foliage of small plants, to approximately 1.0 cc per plant for the large plants in the field plantings. Shortage of material made it necessary to limit the final application on the greenhouse plants of 7512 to 0.25 cc.

Results

Results of the two field experiments, which were established to test the effectiveness of gibberellic acid in stimulating bolting in winter plantings of sugar beet, were largely discouraging. The results are summarized in tables 1 and 2. Of the inbreds and hybrids tested in the September 1957 planting, the F_1 hybrid, F57-554H1, showed the greatest bolting stimulation from gibberellic acid treatment (Table 1). In the early series of applications bolting was 83.0 and 50.0 percent, respectively, for plants receiving five applications of 1000 and 2000 ppm concentrations, whereas, in the late series, bolting was 50.0 and 33.3 percent, respectively, for the five applications of 1000 and 2000 ppm. Plants given one and three applications of both 1000 and 2000 ppm bolted 16.7 percent in the early series but produced no bolters in the late series. Check plots of F57-554H1 did not produce bolters. Very little bolting occurred in either 5502 or 5502H1, and no relationship existed between concentrations or number of applications. The three inbreds, F57-554, 7547 and 7512, and the two hybrids, 7547H1 and 7512H1, did not bolt in the September planting regardless of the treatment.

In the November planting, the F_1 hybrid, F57-554H1, was again the most responsive to treatment with gibberellic acid and showed a progressive increase in bolting, ranging from none for the check plots to 32.0 percent for the plots given six applications (Table 2). The 5502 inbred showed no response to gibberellic acid, but bolted between 25 and 30 percent in both the treated and untreated plots. The 7547 and F57-554 inbreds showed no bolting stimulation from the gibberellic acid treatments. The highly bolting resistant 7512 inbred did not bolt in either the check or treated plots.

The plants which bolted in both field tests did so late in the season and generally were either in full bud or early flower at the conclusion of the experiments on August 18, 1957.

In the experiment with greenhouse-grown plants of 5502 and 7512 which were given varying periods of coldroom exposure, followed by periodic applications of gibberellic acid, it was possible to demonstrate a reduction in the amount of thermal induction required to produce bolting (Table 3). On July 7, 1958, fifteen weeks after

initial gibberellic acid treatment, plants of 5502 which received eleven weeks cold treatment were essentially mature. Seed balls were dry or drying. Drying of the seed on check plants was also occurring but was not as advanced as in treated plants.

At the same time, the plants of 5502 given the eight-week cold treatment, plus gibberellic acid, had largely finished flowering, and although little drying had occurred, viable seed could have been harvested on July 7, 1958. Untreated plants were slightly later than the treated ones. The plants of 5502 which bolted after five weeks in the coldroom were still flowering, and seed which had set was still relatively immature over all levels of gibberellic acid treatment.

Gibberellic acid treated plants of 7512, given eight and eleven weeks in the coldroom, which bolted and flowered were still flowering on July 7, 1958, but seed was not yet ripe. Some drying of seedballs was occurring on all flowering plants at the termination of the experiment on August 18, 1958. Check plants of 7512, which received no gibberellic acid, failed to bolt regardless of the period of coldroom treatment (Table 3).

As the results reported here indicate, bolting-resistant stocks of sugar beets grown under controlled conditions may have their thermal induction requirements reduced significantly when periods of coldroom exposure are followed by treatment with gibberellic acid. For an inbred such as 5502, it is estimated that repeated applications of gibberellic acid of 1000 to 3000 ppm may reduce total coldroom requirement by three to five weeks. A reduction of six to eight weeks seems likely with the use of repeated applications of a 3000 ppm concentration of gibberellic acid on extremely bolting resistant inbreds, such as 7512. The period of coldroom exposure, concentration, and number of applications of gibberellic acid appear to be dependent on the inherent bolting resistance of a given inbred, hybrid, or variety of sugar beet.

Of the inbreds and F_1 hybrids tested in the two field experiments, a consistent response to gibberellic acid was observed only in the F_1 hybrid, F57-554H1. In this number, the plants receiving the most applications of gibberellic acid produced the higher percentage of bolters, whereas, the plants in check plots failed to produce bolters. The poor response to gibberellic acid in the other inbreds and hybrids tested indicates that the stimulation to bolting contributed by gibberellic acid may be expected to be highly variable under field conditions at Salinas. The results obtained in both 1957 and 1958 indicate that the amount of bolting can not be appreciably increased in most bolting resistant breeding material through field applications of gibberellic acid.

Acknowledgment

The gibberellic acid used in these experiments was Gibrel (Merck Gibberellic Acid) supplied by Merck and Co., Inc., Rahway, New Jersey.

Table 1. Bolting response in a September 17, 1957 planting of an F_1 hybrid, an inbred and its male sterile equivalent treated with gibberellic acid.

Variety	Concentration ppm	No. of Appl.	Early series of applications Total Plants	Bolters	Percent Bolting	Late series of applications Total Plants	Bolters	Percent Bolting
F57-554H1 (NB1 x NB4)	0	0	5	0	0.0	5	0	0.0
	1000	1	6	1	16.7	6	0	0.0
	"	3	6	1	16.7	6	0	0.0
	"	5	6	5	83.0	6	3	50.0
	2000	1	6	1	16.7	5	0	0.0
	"	3	6	1	16.7	6	0	0.0
	"	5	6	3	50.0	6	2	33.3
5502H1 (MS of NB1)	0	0	5	0	0.0	5	0	0.0
	1000	1	6	0	0.0	6	0	0.0
	"	3	6	0	0.0	6	0	0.0
	"	5	7	0	0.0	6	1	16.7
	2000	1	6	1	16.7	6	0	0.0
	"	3	6	1	16.7	6	0	0.0
	"	5	6	0	0.0	6	2	33.3
5502 (NB1)	0	0	5	0	0.0	6	0	0.0
	1000	1	4	0	0.0	5	0	0.0
	"	3	5	0	0.0	5	0	0.0
	"	5	5	0	0.0	4	0	0.0
	2000	1	3	0	0.0	5	0	0.0
	"	3	3	0	0.0	5	0	0.0
	"	5	6	0	0.0	5	1	20.0

Table 2. Bolting response in a November 15, 1957 planting of a hybrid and three inbreds treated with 1500 ppm gibberellic acid.

Variety	Number of Applications	Total Plants	Bolters	Percent Bolters
F57-554H1 (NB1 x NB4)	0	26	0	0.0
	2	25	1	4.0
	3	23	3	13.4
	5	25	6	24.0
	6	25	8	32.0
5502 (NB1)	0	23	6	26.1
	2	26	8	30.8
	3	24	5	20.8
	5	24	9	37.5
	6	25	7	28.0
F57-554 (NB4)	0	26	0	0.0
	2	25	0	0.0
	3	24	1	4.2
	5	22	1	4.5
	6	24	0	0.0
7547 (NB5)	0	26	3	11.5
	2	24	1	4.2
	3	19	0	0.0
	5	21	0	0.0
	6	21	2	9.5

Table 3. Bolting in two inbreds given periods of coldroom treatment and applications of gibberellic acid.

Variety	Concentration GA[1/] ppm	Number of applications	Number of plants	Number of bolters	Number of plants to seed	Percent bolters
			5 week coldroom treatment			
5502	0	0	16	0	0	0.0
	1000	1	13	1	1	7.7
	1000	3	5	1	1	20.0
	3000	1	13	4	4	30.8
	3000	3	15	14	14	93.3
7512	0	0	8	0	0	0.0
	1000	1	12	0	0	0.0
	1000	4	12	0	0	0.0
	3000	1	7	0	0	0.0
	3000	4	16	0	0	0.0
			8 week coldroom treatment			
5502	0	0	23	22	22	95.7
	1000	1	23	21	21	91.3
	1000	3	24	24	24	100.0
	3000	1	19	19	19	100.0
	3000	3	23	23	23	100.0
7512	0	0	23	0	0	0.0
	1000	1	22	0	0	0.0
	1000	4	23	0	0	0.0
	3000	1	20	3	3	15.0
	3000	4	20	1	1	5.0
			11 week coldroom treatment			
5502	0	0	23	23	23	100.0
	1000	1	24	24	24	100.0
	1000	2	24	24	24	100.0
	3000	1	24	24	24	100.0
	3000	2	24	24	24	100.0
7512	0	0	24	0	0	0.0
	1000	1	23	5	4	21.7
	1000	4	24	5	5	20.8
	3000	1	24	12	11	50.0
	3000	3	24	17	17	70.8

1/ GA = gibberellic acid.

Preliminary Studies on the Effect of the Selective Gametocide, FW-450, on Sugar Beet

I. O. Skoyen

Preliminary studies carried on in the field and greenhouse during the summer of 1958 showed that complete male sterility of sugar beet could be obtained artifically with the use of spray applications of the selective gametocide FW-450, technically, sodium 2, 3-dichloroisobutyrate.

Greenhouse tests were conducted on thermally induced steckling plants of a group of six inbreds, and the field tests were made largely on plants of US 56/2. Spray applications of 0.5, 1.0, 1.5 and 2.0 percent aqueous solutions of FW-450 were made to plants ranging in stage of flowering from early bud to two or three days before anthesis. The gametocide was applied at the rate of about 0.5 cc per application in the greenhouse and 0.5 to 1.5 cc in the field.

Male sterility of the treated plants was judged by failure of anthers to dehisce, and by the reduced size and discoloration of anthers.

All concentrations of FW-450 were somewhat phytotoxic, but generally caused more severe damage in the greenhouse tests than in the field. Foliage burn, killing of growing points, and distortion and curling of leaf margins were noted within a day or two of treatment. Prolonged phytotoxic effects were indicated by the development of chlorotic branch tips, reduced size of flowers, and a slight thickening of flower sepals, especially from treatment with higher concentrations of FW-450. The chlorotic areas of the branch tips eventually died back to normal green tissue, and the reduced flower size resulted in a reduced seed size particularly at higher concentrations of FW-450.

The results summarized in Table 1 show that male sterility was obtained with FW-450 at concentrations of 0.5, 1.0, 1.5, and 2.0 percent, and that sterility may remain over a rather prolonged period. The death of plants in certain inbred lines following treatment with FW-450 probably was a result of the combination of the effects of FW-450 and the poor condition of the plants. Observations of the treated plants indicated that NB4 and US 56/2, followed by 585, were less sensitive to FW-450 than were other numbers tested. The NB5 inbred appeared to be particularly sensitive to FW-450.

Applying the FW-450 to plants in early bud generally resulted in sterility in early flowering, whereas, treating plants seven to ten days before opening of flowers usually failed to produce sterility in the early flowers. Repeated applications, spaced about ten days apart, appeared to give better and more prolonged sterility than

did single applications. The results indicated that larger applications of lower concentrations of material probably would reduce phytotoxicity and still produce sterility. The period required for male sterility to develop following treatment with FW-450 appeared to be essentially the same, regardless of the stage of flowering of the plants. Sterility was not generally evident much before twenty days after treatment (Table 1.).

Results of germination tests on seed from treated plants showed that injury to the seed apparently did not occur with the concentrations and rates of application of FW-450 which were used in the tests. Percentage germination ranged from two to 100 percent, but seed from plants which received repeated applications of FW-450 often showed as high a percentage germination as did seed from plants which received a single application.

The preliminary studies of the effects of the gametocide, FW-450, on sugar beet indicate that, in general, responses are similar to those reported for cotton by F. M. Eaton, Science 126: 1174-1175, 6 December 1957.

Further testing of FW-450 is now planned, which will include studies to determine the optimum concentration and volumes of application as well as interval between applications. Also, a system of crossing and pollen study will be used, which will make it possible to establish the extent of sterility and viability of pollen of treated plants.

Table 1. Summary of results of treating single plants of six inbreds and one variety of sugar beet with the selective gametocide, FW-450

Concen tration %	Days after treatment	NB1	NB4	NB5	NB6	585	5508-5	US 56/2
0.5	20	Not open	Fertile	Sterile	Sterile	P.Sterile[1]	P.Sterile	Sterile
"	35	Sterile	Fertile	Dead	Sterile	Sterile	Dead	P.Sterile
"	20	Fertile	Fertile			Sterile		Fertile
"	35	Dead	Fertile			Sterile		Fertile
"	20							P.Sterile
"	35							Sterile
1.0	20	Dead	P.Sterile	Dead	Sterile	Sterile	Sterile	Fertile
"	35		Sterile		Dead	Sterile	Sterile	Sterile
"	20	Dead	Sterile			Fertile		
"	35		P.Sterile					
"	20					Sterile		
"	35					Sterile		
1.5	20	Sterile	Sterile	Dead	Sterile	Fertile	Dead	Not open
"	35	Sterile	P.Sterile		Sterile	Fertile		Sterile
"	20		Sterile		Sterile	Fertile	Sterile	P.Sterile
"	35		Sterile		Sterile	Fertile	Dead	Sterile
"	20		Sterile			Sterile		Not open
"	35		Sterile			Dead		Sterile
"	20							Sterile
"	35							P.Sterile
2.0	20	Sterile	Sterile			Sterile		Sterile
"	35	Sterile	P.Sterile			Sterile		Sterile
"	20		Sterile			Sterile		Sterile
"	35		Sterile			Sterile		Sterile
"	20		Sterile					Not open
"	35		Sterile					P.Sterile

[1] P.Sterile = Partially Sterile

PART VII

PRODUCTION OF BASIC BREEDING MATERIAL

and

DEVELOPMENT OF BREEDING PROCEDURES

Foundation Project 25

LeRoy Powers J. W. Dudley

PROGRESS REPORT TO THE BEET SUGAR DEVELOPMENT FOUNDATION ON THE GENETIC AND PLANT BREEDING PHASES OF PROJECT NUMBER 25 1/

by LeRoy Powers and John W. Dudley

Effects of a Gametocide on Sugar Beets

Two experiments, one conducted in the greenhouse and one conducted in the field, were undertaken in 1958 to determine the effects of sodium 2, 3-dichloroisobutyrate (FW-450) on pollen fertility in sugar beets.

Field Experiment

The experimental design for the field experiment is a modified split-split plot with four replications. The whole plots are varieties, the sub-plots are times of application, and the sub-sub plots are concentrations of FW-450. The plant material consisted of 192 roots from each of three commercial varieties: A54-1, A54-6, and A54-7, making a total of 576 roots. The roots were planted April 30, 1958. Each replication consisted of three blocks, each block representing a variety. Each variety block was divided into groups of four rows. One group was given an initial application at emergence (May 19). A second group was given an initial application at early bolting (May 29), while a third group was given an initial application at the pollen mother cell stage (June 6). One row within each group was untreated and served as a check and a pollen source, one was given a treatment of 1/3%, one 1.0% and one 3.0% FW-450 by weight at a carrier rate of 100 gallons per acre. Each row consisted of four plants spaced two feet apart with three feet between rows.

Modifications of the split-split plot design were made to obtain information on the effect of repeated applications. Each plot treated at emergence was split in half, and one-half, chosen at random, was given repeat treatments at the early bolting and pollen mother cell stages, while the other half was given only the emergence spraying. The plots treated at early bolting were also divided, and one-half was given an additional treatment at the pollen mother cell stage.

The means for the characters, number of days from May 31 to first flowering, number of days from first flowering to pollen shedding, percent of plants shedding pollen, and seed yield in grams for the various concentration and time of application combinations are shown in table 1. The only treatments which significantly delayed first flowering were the 1.0% applied three times and the 3.0% applied two and three times. The 1.0% applied three times and the 3.0% applied twice delayed flowering 4-5 days, while the 3.0% applied three times delayed flowering about 8 days.

1/ The breeding and genetic phases of project 25 are cooperative with the Agronomy Department of the Colorado State University Agricultural Experiment Station.

Table 1. Mean number of days from May 31 to first flowering, number of days from first flowering to pollen shedding, percent of plants shedding pollen, and seed yield in grams for the treatments applied in the field gametocide experiment.

Character & Concentration	Emergence	Early Bolting	Pollen Mother Cell	Early Bolting & Pollen Mother Cell	Emergence, Early Bolting & Pollen Mother Cell
Days to First Flowering					
Check	19.2	19.4	20.6	19.4	19.2
1/3%	18.9	20.5	19.7	20.9	21.0
1.0%	18.6	19.5	19.9	20.9	24.6
3.0%	21.0	20.3	20.5	24.6	27.8
Days to Pollen Shedding					
Check	1.9	1.0	1.1	1.0	1.9
1/3%	3.4	5.7	7.7	9.8	10.2
1.0%	4.9	10.8	12.7	12.3	13.4
3.0%	8.2	10.9	11.9	—	7.0
Percent Shedding Pollen					
Check	100.0	97.8	97.8	97.8	100.0
1/3%	95.8	82.6	87.2	70.8	79.2
1.0%	81.8	66.7	38.3	29.2	34.8
3.0%	79.2	65.2	26.1	0.0	4.3
Seed Yield					
Check	131.2	137.2	126.6	137.2	131.2
1/3%	128.9	100.4	104.6	105.0	69.1
1.0%	118.0	90.1	72.7	38.9	27.5
3.0%	77.1	63.1	35.9	10.0	5.9

The means for days from first flowering to pollen shedding are computed, using those plants which actually shed pollen and ignoring those which did not shed pollen. Pollen shedding on the check plots occurred, on the average, one to two days after the first flowers were observed to be open. Of the single applications, those made at the early bolting and pollen mother cell stages with concentrations of 1.0 and 3.0 percent delayed pollen shedding from 10-12 days, while a single application of 1/3 percent at the pollen mother cell stage or of 3.0 percent at emergence delayed pollen shedding from 7-8 days. All of the repeat applications delayed pollen shedding at least 7 days.

Only the 3.0 percent application at early bolting and the pollen mother cell stage had no plants shedding pollen. Of the single applications, the 1.0 and 3.0 percent applications at the pollen mother cell stage gave the most drastic reduction in percent of plants shedding pollen, with the 1.0 and 3.0 percent applications at early bolting also showing a marked reduction in percent of plants shedding pollen. The greatest reductions in percent of plants shedding pollen were found with the repeated applications of the 3.0 percent concentration. The repeated applications of the 1.0 percent solution gave results similar to those obtained from a single application of a 3.0 percent solution at the pollen mother cell stage.

All the treatments except the 1/3 percent applied at emergence reduced seed yield to some extent. The 1.0 perdent application at emergence has the least reduction in seed yield, while the single 1/3-percent applications at early bolting and the pollen mother cell stage, and the double application of 1/3 percent have about the same reduction in seed yield, averaging 103.3 grams per plant compared with 131.7 grams per plant for the average of the checks. The rest of the treatments range from an average of 90.1 grams for the 1.0 percent applied at early bolting to 5.9 grams for the 3.0 percent applied three times.

The number of seedballs which produced at least one healthy sprout in 14 days in the germinator and the percentage of seedballs which germinated, for certain selected treatments, are shown in table 2. These treatments fall into three distinct groups as regards percentage of germination. The 1/3-percent treatment at early bolting is reduced the least in germination percentage. The 1/3-percent treatment at the pollen mother cell stage has an intermediate reduction in germination percentage, while the 1.0-percent treatment at the pollen mother cell stage, the 1.0-percent treatment at early bolting, and the 1/3-percent treatment applied at both the early bolting and the pollen mother cell stages have the greatest reduction in germination percentage.

The results of this field experiment indicate that production of pollen can be delayed significantly by use of FW-450 but that deleterious effects on seed yield and germination percentage are also apt to occur.

Table 2. Number of seedballs which germinated and number which did not germinate, and the percentage of germination for certain treatments from the 1958 field gametocide test.

Treatment	Germinated	Not Germinated	Total	Percent Germinated
Check	393	407	800	49.1
1/3% PMC[1]	287	513	800	35.9
1.0% PMC	185	615	800	23.1
1/3% EB[2]	349	451	800	43.6
1/3% EB & PMC	208	592	800	26.0
1.0% EB	232	568	800	29.0

1. PMC designates pollen mother cell.
2. EB designates early bolting.

Greenhouse Experiment

The greenhouse planting consisted of 40 quarter roots each of two inbred lines--52-407, which has a red root, and 54-565, which has a yellow root. The quarters of each of these lines were alternated. Spray applications consisted of a 0.5 percent solution of FW-450 applied at the rate of 100 gallons per acre. Alternate pairs of plants, one of each inbred, were sprayed. Thus half of the plants of each line were treated, while the other half were untreated and served as pollen parents and as a check on the effectiveness of the spray applications. Of the pairs of plants which were sprayed, one-half were given two applications--one at the emergence stage (April 28) and one at the early bolting stage (May 12). The other pairs of plants which were sprayed were given an additional spraying at the pollen mother cell stage (May 26).

The results of hypocotyl color counts on seed obtained from 54-565, the yellow rooted parent, are shown in table 3. Since 54-565 is rr and 52-407 is RR, any red hypocotyl plants in the progeny of 54-565 must have resulted from crosses with 52-407 and would be Rr. Thus the percentage of red hypocotyl plants obtained from 54-565 is a measure of the effectiveness of the gametocide. From table 3 it can be seen that the percentage of red hypocotyl plants in a composite sample of the untreated check plants of 54-565 is only 3.51 percent. This indicates that 54-565 is mostly self-fertile, since 50 percent red hypocotyl plants would be expected if 100 percent crossing had occurred. The progeny of plants of 54-565 which were sprayed twice have 13.89 percent red hypocotyl plants, while progeny of those which were sprayed three times have 40.27 percent red hypocotyl plants. Assuming that the percentage of red hypocotyl plants represents half of the cross-pollination which occurred, the other half coming from r pollen grains produced by rr plants, the percentages of crossing are 7.02 for the check; 27.78 for those plants sprayed twice; and 80.54 for those plants sprayed three times. From

examination of table 3, it is obvious, without further statistical analysis, that the proportion of red hypocotyl plants, and thus the percentage of crossing, is significantly higher for the plants sprayed three times than for either the check or those sprayed twice.

Table 3. Number of red and yellow hypocotyl seedlings found by germination of greenhouse seed obtained from plants of 54-565.

	Hypocotyl color			
Treatment	Red	Yellow	Total	% Red
Check	68	1872	1940	3.51
Sprayed twice	208	1289	1497	13.89
Sprayed three times	385	571	956	40.27

The mean seed yield, in grams, for the two treatments and the check for each inbred are shown in table 4. Study of this table reveals that seed yield of 54-565 was not reduced by two applications of FW-450 and that three applications reduced seed yield only 10 grams per plant. For 52-407, two sprayings reduced seed yield 18.61 grams, while the third spraying reduced seed yield an additional 15.49 grams. These results indicate that some genotypes may be able to withstand heavier doses of FW-450 than others, without significant reduction in seed yield.

Table 4. Mean seed yield per plant in grams for treatment x inbred line combinations from greenhouse gametocide test.

	Number of sprayings			
Inbred	Check	Two	Three	Mean
54-565	132.11	133.80	122.11	130.18
52-407	126.21	107.60	92.11	113.24
Mean	129.16	120.70	107.11	121.71

The numbers and percentages of seedballs germinated from the greenhouse seed are shown in table 5. From this table it can be seen that two treatments of FW-450 slightly increased the germination percentage for both inbred lines, while three sprayings caused a significant decrease in germination percentage for both inbred lines. The decrease obtained from 52-407 sprayed three times is significantly larger than that for 54-565 sprayed three times. Thus there are differential responses to FW-450 in both seed yield and germination percentage. The deleterious effects of FW-450 were more pronounced on inbred 52-407 in both cases.

Table 5. Number of seedballs which germinated and number which did not germinate, and the percentage of germination for seed from the greenhouse gametocide test.

Inbred & Number of Sprays	Germinated	Not Germinated	Total	Percent Germinated
54-565				
Check	697	103	800	87.1
Two	730	70	800	91.2
Three	609	191	800	76.1
52-407				
Check	694	106	800	86.8
Two	713	87	800	89.1
Three	466	334	800	58.2

Pollen Storage Study

An experiment to determine the effect of storage at low temperatures on the viability of sugar beet pollen was started in 1957. Pollen was collected from plants of inbred lines 574 and 575 which were grown in the greenhouse. The pollen was then stored at zero degrees Fahrenheit on the following dates after the indicated pre-storage treatment:

1. stored in gelatin capsules, 3-11-57.
2. refrigerated 9 hours and stored in glass vials, 3-14-57.
3. refrigerated 9 hours and stored in gelatin capsules, 3-14-57.
4. dried at room temperature 7-1/2 hours and stored in glass vials, 3-20-57.
5. dried at room temperature 7-1/2 hours and stored in gelatin capsules, 3-20-57.

The pollen was placed in the capsules or vials immediately after collection. The containers were closed with loose cotton stoppers and placed in a larger container over a layer of calcium chloride. The larger container was then closed with a tight fitting lid.

Two paper pollinating bags were placed on each of thirty plants of U. S. 400 on June 28, 1957. Care was taken to bag branches as nearly alike in stage of flower development as possible. The thirty plants represented three replications of 10 plants each. Pollen from 575 was applied to five of the 10 plants in each replication, and pollen from 574 was applied to the other five plants. Each of the five plants to which pollen of a given inbred was applied had pollen from one of the five pre-storage treatments applied in one bag and fresh pollen of the same inbred line in the other bag. The fresh pollen was collected from the greenhouse on the day that it was applied. Pollen applications were made on July 8, 10, and 12. Thus the pollen was stored for about four months.

Since inbreds 574 and 575 are both red rooted and U.S. 400 has white roots, the effectiveness of the stored pollen could be measured by the percentage of the progeny from the bagged seed having red roots. An attempt was made to determine the percentage of hybrids by germinating the seed in the germinator. Since no clear distinction between the red hypocotyl plants resulting from selfing of the U.S. 400 parent and the red-rooted plants of the hybrids was obtained, the seed not used in the germinator test was planted in the field in 1958 and the number of red- and white-rooted plants in the progeny counted at harvest. The results of this count are shown in table 6. From this table it can be seen that there is essentially no difference between the effectiveness of the stored and the fresh pollen except for treatment two on inbred 574. Since the data represent only one replication, this difference may have been caused by failure of the branch receiving the stored pollen to flower at the time the pollen was applied. The results of this experiment indicate that sugar beet pollen can be stored for as long as four months at zero degrees Fahrenheit without losing its ability to effect fertilization.

Table 6. Numbers of red-and white-rooted plants obtained for different pre-storage treatments and pollen parents.

Pre-storage Treatment[1]	575				574			
	Stored		Fresh		Stored		Fresh	
	Red	White	Red	White	Red	White	Red	White
1	3	0	6	0	34	19	0	1
2	13	4	68	4	0	16	44	14
3	88	3	95	3	5	6	39	3
4					53	4	17	2
5	18	2	40	1	81	1	96	6
Total	122	9	209	8	173	46	196	26

1. See text for description of pre-storage treatments.

Table 7. Mean parts per 100,000 of sodium and potassium for the interaction of replications x populations x treatments.

Character & Population	Treatment and Replication Group									
	Non-fertilized					Fertilized				
	1-8	9-16	17-24	25-32	33-40	1-8	9-16	17-24	25-32	33-40
Sodium										
A54-1	14.36	14.53	19.02	32.09	54.92	31.59	34.30	37.14	55.41	80.92
A54-1, BB	14.56	13.58	18.26	33.05	45.77	39.95	26.36	35.94	65.26	80.41
50-406, BB	8.61	10.72	14.31	23.47	40.19	18.34	21.23	21.36	40.34	56.22
50-406	8.38	9.77	14.16	22.42	33.48	21.81	22.16	28.12	42.34	52.77
F_1 hybrid	8.72	9.45	14.19	24.19	42.81	18.50	20.08	24.12	44.62	59.94
52-307	14.19	14.69	19.70	31.05	49.61	27.84	27.84	30.50	56.20	74.50
Potassium										
A54-1	119.00	112.94	114.22	131.72	135.17	131.98	116.67	121.45	134.72	160.80
A54-1, BB	108.48	108.83	109.66	118.06	127.12	126.55	122.31	113.39	132.22	154.12
50-406, BB	93.52	98.42	92.92	97.97	113.88	106.73	108.53	106.12	106.08	135.23
50-406	96.11	98.20	92.31	108.81	123.48	122.06	121.12	116.36	120.86	132.69
F_1 hybrid	97.47	92.77	89.31	99.55	100.89	103.81	99.70	97.23	96.83	111.77
52-307	109.53	103.77	103.11	114.75	102.62	100.66	99.88	95.83	98.81	101.73

Population Genetic Studies

I. Sodium and Potassium 1/

A preliminary report of the results of the population genetic studies on sodium and potassium was included in the 1958 report to the Beet Sugar Development Foundation. Since that time, the analysis of the sodium and potassium data has been completed, and information which may be of interest regarding the breeding behavior of these characters is now available. This information will be discussed under four headings: means, variances, individual frequency distributions, and joint frequency distributions.

Means

The means for the interaction of replications x populations x treatments in parts per 100,000 of sodium and potassium are shown in table 7. The information of interest in this table concerns the dominance relationships exhibited by the F_1 hybrid and the two inbreds. On the non-fertilized plots, low sodium is dominant in the first four replication groups, while the F_1 is intermediate in sodium content on the last replication group. On the fertilized plots, the F_1 is slightly lower than the low parent on the first three replication groups and slightly higher than the low parent on the last two replication groups. Thus, depending upon the replication group and fertility level studied, there are indications of complete dominance, intermediacy, and heterosis for low sodium.

The F_1 hybrid is lower in potassium than either parent in all replication groups on the non-fertilized plots except group 1-8. In group 1-8 the F_1 is not significantly different from the low parent. 50-406 is the low parent in all replication groups on the non-fertilized plots except group 33-40. On the fertilized plots, 52-307 is the low parent in all replication groups. Thus, depending upon the replication group and fertility level studied, there is either dominance or heterosis for low potassium. The parent which is high or low in potassium in the cross also varies with the fertility level and replication studied.

Variances

The mean within-plot obtained and residual variances for sodium and potassium are shown in table 8. The original data were transformed to logarithms of parts per 100,000 for statistical analysis, because the environmental variability of the untransformed data was not following the normal curve. The variances, therefore, are reported in terms of the variances of the logarithms. Comparisons between the F_1 hybrid variances and the variances of the heterogeneous populations reveal that there are significant residual variances in all the heterogeneous populations for both characters on both

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1/ The sodium and potassium determinations were made by the Holly Sugar Corporation Research Department.

fertility levels. This indicates that it should be possible to select individuals which are genetically high or low in sodium and/or potassium and justifies proceeding with an analysis of the frequency distributions.

Other information of interest is obtained from table 8 by comparing the variances of A54-1 and 50-406 with those of A54-1, BB and 50-406, BB. The variance of A54-1, BB is not significantly larger than that of A54-1 for either character on either fertility level, while that of 50-406, BB is significantly larger than that of 50-406 for both characters on both fertility levels. This can be explained by assuming that A54-1, a commercial variety, is heterogeneous and heterozygous enough to encompass the range of variability found for sodium and potassium in all 22 of the pollen parents used in creating the broad base populations, while 50-406, an inbred line, is relatively homogeneous and homozygous for the two characters, and that the increased variability of 50-406, BB is caused by increased genetic variance.

Table 8. Mean within-plot obtained and residual variances of logarithms of parts per 100,000 of sodium and potassium for the interaction of populations and treatments.

Population & Treatment	Sodium Obtained	Sodium Residual	Potassium Obtained	Potassium Residual
Fertilized				
A54-1	0.051484	0.033719	0.008035	0.003598
A54-1, BB	0.051962	0.034197	0.008543	0.004106
50-406, BB	0.037057	0.019292	0.007845	0.003408
50-406	0.027592	0.009827	0.005631	0.001194
F_1 hybrid	0.017765		0.004437	
52-307	0.016575*	-0.001190	0.002909*	-0.001528
Non-fertilized				
A54-1	0.034858	0.026798	0.008582	0.004841
A54-1, BB	0.044729	0.036669	0.007615	0.003874
50-406, BB	0.019482*	0.011422	0.006600*	0.002859
50-406	0.013083*	0.005023	0.004700*	0.000959
F_1 hybrid	0.008060		0.003741	
52-307	0.015369	0.007309	0.004968	0.001227

Starred (*) variances have 279 degrees of freedom, all others have 280. Tabular F for comparison between variances is 1.26 at the 5% level and 1.39 at the 1% level.

Individual Frequency Distributions

The numbers and proportions of individuals genetically low and high in sodium and potassium are shown in table 9. The number of genetically low or high individuals for each population-treatment combination is the number genetically low or high out of 320. For the sodium data on the fertilized plots, the number of high and low genetic deviates in populations A54-1 and A54-1, BB are different from zero with odds greater than 99:1. For 50-406, BB, the number of high genetic deviates is significant with odds greater than 99:1, while the number of low genetic deviates is significant with odds of 60:1. On the non-fertilized plots, the number of high genetic deviates in populations A54-1 and A54-1, BB are different from zero with odds of greater than 99:1. Only A54-1, BB has a significant number of low genetic deviates on the non-fertilized plots. Population 50-406, BB has no significant number of genetic deviates in either the high or low class on the non-fertilized plots. These results indicate that selection for low sodium content can be more readily accomplished on the fertilized plots, while selection for high sodium can be more readily accomplished on the non-fertilized plots. Comparisons of populations within treatments reveals that selection for low sodium should be more successful in population A54-1, since this population contains both a larger number and a larger proportion of genetic deviates than either of the other populations. Populations A54-1 and A54-1, BB are superior to 50-406, BB for selection of genetically high sodium individuals, since the genetic deviates fall into higher classes of the frequency distributions and since the numbers and proportions of genetic deviates are higher than in 50-406, BB.

The numbers of high and low genetic deviates in the potassium data for each population on both fertility levels are different from zero with odds greater than 99:1. Study of the detailed frequency distributions revealed that the breeding behavior of the heterogeneous populations is almost identical on the two different fertility levels. Selection for low potassium should be most effective in population 50-406, BB, because the low genetic deviates fall into lower classes of the frequency distribution than for the other populations. Similarly, selection for high potassium should be most effective in population A54-1, because the high genetic deviates fall into higher classes of the frequency distribution than for the other populations.

Joint Frequency Distributions

The joint frequency distributions for sodium and potassium are of interest in determining the possibility of altering sodium and potassium content simultaneously. The four classes: low sodium-low potassium, low sodium-high potassium, high sodium-low potassium, and high sodium-high potassium were studied. The number of individuals obtained, expected on the basis of the joint environmental frequency distributions, and the number and proportions of joint genetic deviates are shown in table 10. For the high-high class, the proportion of joint genetic deviates varies from 0.83 to 0.91. Tests of significance of the number of joint genetic deviates reveal that all the numbers of high-high genetic deviates are different from zero with odds of at least 99:1. Thus the choice of a fertility level and a population in which to select for individuals high in both characters depends on the number

Table 9. Numbers and proportions of genetically low and high individuals in heterogeneous populations for sodium and potassium on fertilized and non-fertilized plots.

Character, Population & Distribution	Treatment & Class			
	Fertilized		Non-fertilized	
	Low	High	Low	High
Sodium				
A54-1				
Obtained	55	91	175	28
Calculated	34	67	159	13
Difference	21	24	16	15
Proportion	0.38	0.26	0.09	0.54
A54-1, BB				
Obtained	64	70	72	38
Calculated	32	44	55	19
Difference	32	26	17	19
Proportion	0.50	0.37	0.24	0.50
50-406, BB				
Obtained	33	39	101	27
Calculated	21	23	89	21
Difference	12	16	12	6
Proportion	0.36	0.41	0.12	0.22
Potassium				
A54-1				
Obtained	90	51	40	85
Calculated	60	20	10	48
Difference	30	31	30	37
Proportion	0.33	0.61	0.75	0.44
A54-1, BB				
Obtained	109	88	46	33
Calculated	73	53	25	9
Difference	36	35	21	24
Proportion	0.33	0.40	0.46	0.73
50-406, BB				
Obtained	66	53	55	25
Calculated	46	26	33	10
Difference	20	27	22	15
Proportion	0.30	0.51	0.40	0.60

Table 10. Obtained[1] and calculated numbers and numbers and proportions of genetic deviates for certain classes of the joint frequency distributions for sodium and potassium.

Treatment, Population & Distribution	Class: Low Na Low K	Low Na High K	High Na Low K	High Na High K
Fertilized				
A54-1				
Obtained	25	0	12	31
Calculated	6	2	13	4
Difference	19			27
Proportion	0.76			0.87
A54-1, BB				
Obtained	28	9	9	47
Calculated	7	5	10	7
Difference	21	4		40
Proportion	0.75	0.44		0.85
50-406, BB				
Obtained	8	2	5	21
Calculated	3	2	3	2
Difference	5		2	19
Proportion	0.62		0.40	0.90
Non-fertilized				
A54-1				
Obtained	26	26	2	12
Calculated	5	24	0	2
Difference	21	2	2	10
Proportion	0.81	0.08	1.00	0.83
A54-1, BB				
Obtained	12	2	2	11
Calculated	4	2	1	1
Difference	8		1	10
Proportion	0.67		0.50	0.91
50-406, BB				
Obtained	20	2	2	10
Calculated	9	3	2	1
Difference	11			9
Proportion	0.55			0.90

1. The obtained and calculated numbers are those obtained and calculated on the basis of a population of 320 individuals.

of individuals falling in the high-high class. The fertilized plots have from two to four times as many individuals in the high-high class as do the non-fertilized plots. Within the fertilized plots, A54-1, BB has the largest number of individuals in this class. Thus A54-1, BB on the fertilized plots should be the most fruitful source of individuals high in both sodium and potassium. For the low-low class, the numbers of genetic deviates are different from zero with odds of at least 35:1 for all population-treatment combinations. On the fertilized plots, A54-1 and A54-1, BB have the largest numbers and proportions of joint genetic deviates in the low-low class; while on the non-fertilized plots, A54-1 has the largest number and proportion of low-low genetic deviates. Examination of the detailed frequency distributions revealed that the individuals in population 50-406, BB fall into lower classes than do those of either A54-1 or A54-1, BB. Thus if the plant breeder wants extremely low sodium and potassium, he probably would want to work within population 50-406, BB.

In the low sodium-high potassium class, only A54-1, BB on the fertilized plots and A54-1 on the non-fertilized plots have joint genetic deviates. In neither case are numbers of deviates significantly different from zero. For the high sodium-low potassium class, joint genetic deviates are found in 50-406, BB on the fertilized plots and in populations A54-1 and A54-1, BB on the non-fertilized plots. For A54-1, the odds are 21:1 that the number of deviates is different from zero. Only two high sodium-low potassium individuals are found in A54-1 on the non-fertilized plots, but these individuals are identifiable as genetically high in sodium and low in potassium, since none were expected. Thus it may be possible to select for high sodium and low potassium simultaneously, although it will be more difficult than selecting in either the high-high or low-low classes.

Experiments Involving the Selection Method and the Polycross Method of Breeding

Some of the information derived from the experiments involving the selection method and the polycross method of breeding sugar beets may be of interest to the members of the Beet Sugar Development Foundation.

In 1956, three selections were made at two fertility levels. These were made from small units in order to more efficiently control environmental variability. The two fertility levels will be termed high fertility and low fertility. The high fertility plots received a surface application of 100 pounds of N and 250 pounds of P_2O_5 per acre on April 4, 1956. The fertilizer was cultivated under with a rototiller. The experiment was planted on April 10 and 11. On June 26, another 100 pounds of N per acre was drilled in the center of each space between rows of the fertilized plots. The low fertility plots did not receive any application of fertilizer. Analysis of petioles just before harvest showed the petioles from the low fertility plots to be decidedly lower in nitrate nitrogen than those from the high fertility plots.

In two of the experiments, selections were made from border rows of a population genetic study. The border rows were planted to A54-1, so that these selection experiments using small units could be conducted. The units were composed of 12 plots of 24 plants each. However, selections were made from only 6 of the 12 plots, as the other 6 rows were planted to 6 different populations for the purpose of making genetic studies. There were 40 units, making a potential of 5760 plants for each fertility level from which selections in these border rows were made. The number of plants selected from this potential of 5760 was 40 for each fertility level. These were planted in isolated plots in 1957 and open-pollinated seed was harvested from each plant. Also, these plants were self-pollinated and propagated asexually.

The third mass selection experiment was conducted on an immediately adjacent area of low fertility level. Also, this area was planted to A54-1. For selection purposes, it was divided into 40 units each composed of 12 single-row plots having 24 plants per row. Potentially, a total of 11,520 plants was available for selection in this third experiment. In all three selection experiments a near perfect stand was obtained at the time of thinning. There were a few plants lost during the growing season. However, excellent stands remained at the end of the growing season and only competitive roots were selected; that is, beets which had beets growing on four sides of them.

The environmental variances calculated from the F_1 and the two inbred lines grown in the population genetic studies were used to aid in the identification of those individuals for which the odds were greatest that they were genetically superior. In the first two selection experiments, 40 roots were selected for each; and in the third experiment, 32 roots were selected.

Plants from seed of the 40 high fertility selections were grown in a polycross test in 1958. The 1958 polycross test was planted as four units per replication, with 10 selections and two checks (A54-1) in each unit. The 12 populations were randomized within each unit of the five replications. Any given group of 12 populations was kept together in all replications; that is, planted in the same unit in each replication. The units were randomized within replications. In the 1958 polycross test, the center row (three

row plots), potentially composed of 24 plants, was harvested. The stands were excellent throughout the experiment. For the 1958 polycross test, all data were taken on a single-row plot basis.

The design of the experiment was essentially the same for 1957 and 1958. However, in 1957 there were only three units per replication, and the third unit was composed of 12 selections and two checks rather than 10 selections and two checks. In both years there were five replications. In the 1957 polycross test, 20 competitive plants were harvested from the center row of each plot with the exception that, occasionally, in order to have 20 competitive plants from each plot, a few were taken from the two outside rows. The 20 competitive plants from each plot were trimmed as mother beets, and the percentage sucrose and weight per root data were taken on the basis of individual plants. Taking the data on the basis of individual plants made possible population genetic studies pertaining to the evaluation of breeding methods. Recurrent selection was practiced among the progeny of these 32 mother beets. When making recurrent selections, first the roots were chosen on the basis of percentage sucrose and, second, on the basis of weight per root. The total number of beets from which selections were made was 3200. There were five replications of 20 beets per replication and there were 32 selections. From these 3200 beets in the 1957 polycross test, 55 were selected for progeny testing.

The experimental design for the polycross tests of 1957 and 1958 makes possible analyzing the data as three randomized complete blocks in 1957 and four randomized complete blocks in 1958. The data can be combined within years and, if so desired, for years by adding sums of squares and pooling degrees of freedom. As yet, the polycross test has not been made on the progeny of the 40 mother beets selected from the border rows of the low fertility plots of the population genetic studies.

The means for percentage sucrose and weight of roots per plot for the 1957 and 1958 polycross tests are given in table 11.

Table 11. Means for percentage sucrose and weight of roots per plot, 1957 and 1958 polycross tests.

Character and population	1957 Mean	1957 Percent of A54-1	1958 Mean	1958 Percent of A54-1
Sucrose, %				
Selections	15.1	100.0	15.3	98.1
A54-1 (check)	15.1	100.0	15.6	100.0
Weight, Lbs.				
Selections	40.22	107.1	33.99	106.1
A54-1 (check)	37.56	100.0	32.03	100.0

In interpreting the data in table 11, it is helpful to have in mind that the selections were first chosen for large size of root and, second, for high percentage sucrose. Also, it is well to have in mind that the polycross test

composed of 24 plants,was harvested. The checks were
out the experiment. In the 1958 polycross test,all data
a single-row plot basis.
of the experiment was essentially the same in 1957 and 1958.
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each plot, a few were taken from the two outside rows. The
plants from each plot were retained as mother beets,and the
sucrose and weight per root data were taken on the basis of indi-
Taking the data on the basis of individual plants made possible
tic studies pertaining to the evaluation of breeding methods.
on was practiced among the progeny of these as mother beets.
current selections. First the beets were chosen on the basis
e sucrose and,second,on the basis of weight per root. The total
from which selections were made was 1200. There were five
20 beets per replication and there were 12 selections. From
in the 1957 polycross test,55 were selected for [illegible]

design for the polycross tests of 1957 and 1958 makes
the data as three randomized complete blocks in 1957 and
five blocks in 1958. The data can be combined within
so desired,for years by adding sums of squares and pooling degrees
yet,the polycross test has not been made on the progeny of
beets selected from the border rows of the low fertility plots
tion genetic studies.
s for percentage sucrose and weight of roots per plot for the
polycross tests are given in table 11.

11. Means for percentage sucrose and weight of roots per plot, 1957 and 1958 polycross tests.

	1957		1958	
tion	Mean	Percent of ASH-1	Mean	Percent of ASH-1
%				
ctions	15.1	100.0	15.0	98.1
1 (check)	15.1	100.0	15.6	100.0
ght Lbs.				
als done	40.28	107.1	33.99	106.1
1 check)	37.56	100.0	32.03	100.0

the data in table 11,it is helpful to have in mind that the
chosen for large size of root and,second,for high
. Also,it is well to keep in mind that the polycross test

for 1957 was from open-pollinated seed of 32 mother beets selected from a total of approximately 11,520 plants. The polycross test for 1958 was from open-pollinated seed of 40 mother beets selected from a total of approximately 5,760 plants. The selections were made from A54-1.

For 1957, the means of the selections and A54-1 are the same for percentage sucrose. For 1958, the means of the selections averaged 0.3 percent less sucrose than A54-1. However, this could well be a chance deviation, as the odds were considerably less than 19:1 against this difference being due to chance.

The mean weight of roots per plot of the selections exceeded that of A54-1 by 7.1 percent in 1957 and by 6.1 percent in 1958. These increases in weight of root of the selections over the variety from which they were produced are highly significant, as the odds are greater than 99:1 against their being chance deviations. The 32 mother beets giving rise to the 1957 polycross test were selected from plants grown on a soil of low fertility, whereas the 40 mother beets giving rise to the 1958 polycross test were grown on a soil of comparatively high fertility. The 1-percent difference attributable to the interaction (107.1-106.1, see table 11) is not significant. The polycross test measures general combining ability of those individual mother beets largely cross-pollinated. Apparently selection is effective in isolating mother beets having superior combining ability for weight of roots. It would seem that in making these selections percentage sucrose can be maintained. Further analysis of the data from the polycross test provides additional information whether such is the case and whether there is a possibility of simultaneously increasing combining ability for percentage sucrose and weight per root. Also, further analyses of the data should provide other genetic information of value to the plant breeder.

The within-groups analyses of variance for percentage sucrose and weight of roots per plot, combining the data from the 1957 and 1958 polycross tests, are given in table 12.

Table 12. The within-groups analyses of variance for percentage sucrose and weight of roots per plot, 1957 and 1958 polycross tests.

Character and source of variation	Mean square	D. F.	F value	F value at 1%	F value at 5%
Sucrose, %					
Selections	0.9013	65	1.51	1.47	1.32
Replications	3.2865	28	5.50	1.74	1.49
Error	0.5974	323			
Weight, Lbs.					
Selections	44.4955	65	3.67	1.76	1.49
Replications	34.9464	28	2.88	2.00	1.63
S X R	24.6071	260	2.03	1.64	1.42
Error	12.1240	63			

The analyses of variances for percentage sucrose and weight of roots per plot were calculated within groups and within years. Also, the analyses of variance for the two A54-1 entries within each group and within years were calculated separately, so as to provide an error for evaluating the reliability of the interaction of selections X replications. The mean square for selections is a measure of the genetic variability of the population of mother beets as regards general combining ability. The mean square for replications measures the environmental variability due to replications. Hence the selections X replications mean square measures the variability due to this genetic-environmental interaction.

An examination of table 12 reveals that there are genetic differences between selections for both percentage sucrose and weight of roots per plot. Also, there are environmental differences as represented by replications, and the genetic-environmental interaction is statistically significant for weight per root but was not for percentage sucrose; and, hence, in the latter case, was included in the estimate of error. The findings that genetic differences existed between selections for both percentage sucrose and weight per root show that further selection between selections should be effective for both of these characters. The data for 1957 having been taken on an individual plant basis provide a means of determining comparative genetic variability of the selections and of the selections and the parent (A54-1) from which they were derived.

The mean of the within-plot variances for percentage sucrose of the progeny of the 32 mother beets is 2.0542, and the corresponding variance for A54-1 is 2.2439. The degrees of freedom are 3040 and 570, respectively. The F value for determining whether the within-plot variance for A54-1 is greater than that for the selections is 1.09, and the F value at the five-percent point for 500 degrees of freedom and over 1000 degrees of freedom is 1.11. The data are not conclusive in showing that the variance of the progeny of the 32 mother beets is less than that of the A54-1 parent from which the 32 mother beets were selected. However, indications are that such may be the case.

The within-group analysis of variance of the within plot variances for percentage sucrose, 1957 polycross test, are given in table 13.

Table 13. The within-groups analysis of variance of the within-plot variances for percentage sucrose, 1957 polycross test.

Sources of variation	Mean square	D. F.	F value	F value at 1%	F value at 5%
Selections					
Populations	1.0072	29	2.21	2.47	1.88
Replications	1.4445	12	3.17	2.93	2.13
P X R	0.9299	116	2.04	2.21	1.74
A54-1 (check)					
Populations	0.0232	3			
Replications	0.5333	12	1.10	4.16	2.69
P X R	0.4848	12			
Pooled (error)	0.4551	27			

The data listed in table 13 provide information as to whether populations and replications differ in the magnitude of the within-plot variances. A study of table 13 reveals that populations differ, replications differ, and there is a difference between populations as to the magnitude of their variances for different replications. There are no differences for A54-1. It will be recalled that populations for A54-1 are identical, being two entries planted from one seed lot. Hence, the error is calculated from the pooled sums of squares and degrees of freedom.

The fact that selections differ in the magnitude of their variances indicates recurrent selection within the progeny of certain selections might be more effective than recurrent selection within the progeny of other selections. Hence, a study of the within plot variances of the progeny of individual mother beets is of interest.

The means for weight per root and within plot variances for the selections and for A54-1 are given in table 14.

Table 14. The mean weight per root within plot variances, degrees of freedom, and F values for selections and A54-1, 1957 polycross test.

Population	Mean	Variance	D. F.	F value Obtained	F value 1%
Selections	2.01	0.9669	3040	1.16	1.13
A54-1 (check)	1.88	0.8352	570		

An examination of table 14 reveals the odds to be greater than 99:1 against the difference between the within-plot variance for selections and the corresponding variance of A54-1 being due to chance. As previous studies have shown the magnitude of the variances for weight per root and the magnitude of the means to be positively associated, this difference noted between within-plot variances could be due to differences in the magnitude of the means. To determine whether such was the case, the regression of the within-plot variances on the means was calculated and the within-plot variances estimated on the basis of the magnitude of their corresponding means.

To obtain additional genetic information of interest to the plant breeder after calculating the estimated within-plot variances, the progeny of the 32 mother beets were arranged in order of the magnitude of the means for weight per root and divided into four classes, each composed of the progeny of eight mother beets. Those having the largest means were designated as class 1; and those having the smallest means, as class 4. The means and obtained, estimated, and residual variances are listed in table 15.

Table 15. The class means, obtained, estimated, and residual within-plot variances for weight per root, 1957 polycross test.

Class and A54-1 (check)	Mean	Variance		
		Obtained	Estimated	Residual
1	2.21	1.2688	1.1325	0.1363*
2	2.04	0.9924	0.9936	-0.0012
3	1.95	0.8563	0.9184	-0.0621
4	1.83	0.7500	0.8183	-0.0683
Average	2.01	0.9669	0.9657	0.0012
A54-1(check)	1.88	0.8352	0.8415	-0.0063

* By the t test the odds against this residual variance being a chance deviate from zero are greater than 99:1. The other residual variances are not significantly different from zero at the 5% level.

The only residual variance significantly different from zero is that for class 1. This class is composed of the eight progenies having the highest mean weight per root. Since the estimated within-plot variance is calculated by employing the environmental regression of the variances on their corresponding means, the magnitude of the means has been taken into account. Hence, this residual variance can be attributed to genetic causes and is that portion of the genetic variance in excess of the average genetic variance of the entire experiment, including A54-1. The fact that the average residual variance for the selections of 0.0012 and that for A54-1 of -0.0063 is not significantly different from zero furnishes rather conclusive evidence that the difference between the within-plot variance of the selections and the within-plot variance of A54-1 was due to the differences in the magnitude of the means. Such being

the case, considerable confidence can be placed in the finding that the progenies grouped in class 1 have larger genetic variances, on the average, than the progenies of the balance of the selections and larger genetic variances than the A54-1 parent from which they were derived.

When interpreting these results, it is well to keep in mind that the polycross test as applied in these studies measure the general combining ability of the 32 mother beets grown in the isolated seed plot. Such being the case, it seems logical that the eight mother beets whose progeny composed class 1 were genetically superior to the average of the plants of A54-1 because they exhibited heterosis for weight per root. Also, to a great extent their progeny must have resulted from cross-fertilization. Another logical deduction is that at least some of these original eight mother beets should be genetically superior breeding material, especially if the breeding program is planned to take advantage of combining ability. These findings are for yield of root as measured by weight per root and weight of roots per plot. It seems desirable to consider further the data from the eight progenies of the selections grouped in class 1. To do this, the data from the two progenies having the greatest residual variances for weight per root were listed in table 16. These are the progenies from selections 11W-45 and 4W-34. The estimated within-plot variances for percentage sucrose are those for A54-1 (check) for the group in which the selection was grown. As before, the estimated within-plot variances for weight per root were calculated by employing regression of the variances on the mean weight per root.

Table 16. The means, and obtained and estimated within-plot variances for weight of root and percentage sucrose, selections 11W-45 and 4W-34, 1957 polycross test.

Character, selection and check	Mean	Variance		
		Obtained	Estimated	Residual
Weight, Lbs.				
11W-45	2.24	1.4213	1.1615	0.2598
A54-1	1.96	0.8962	0.9168	-0.0206
4W-34	2.18	1.4171	1.1075	0.3096
A54-1	1.83	0.7176	0.8044	-0.0868
Sucrose, %				
11W-45	15.1	2.0986	2.0719	0.0267
A54-1	15.2	2.0719		
4W-34	16.0	2.7475	2.6021	0.1454
A54-1	15.5	2.6021		

From table 16 it can be seen that for weight per root selections 11W-45 and 4W-34 have greater weight per root and larger variances than does A54-1. The odds are greater than 99:1 against the differences being due to chance. For percentage sucrose, in both cases the variances are larger than those for A54-1; but taken individually, the differences are not significant at the 5% level. The mean percent sucrose for 4W-34 is significantly larger than the mean of A54-1 grown in the same group. It is evident from these results that the genetic variability of 11W-45 and 4W-34 is greater than that for A54-1, as regards weight per root, and at least equal to that of A54-1 for percentage sucrose. The progeny of 4W-34 represents an advance in both weight per root and percentage sucrose, as shown by a comparison of the means. Further, this selection and its progeny should furnish an excellent source of breeding material for those programs designed to take advantage of combining ability.

Recurrent selection was practiced among the 3200 plants of the progeny of the 32 mother beets harvested from the 1957 polycross test. The selection was first for percentage sucrose and, second, for weight per root. At the time the selections were made, the particular progeny from which selection was being made was not known, as the cards on which the percentages sucrose and weights were recorded carried only 1957 culture numbers to identify them. The number of roots selected from 11W-45, 4W-34, and the balance of the polycross test, together with the means for percentage sucrose and weight per root, are listed in table 17.

Table 17. Number of roots selected from 11W-45, 4W-34, and the balance of the polycross test, together with the means for percentage sucrose and weight per root.

Selection	Number	Sucrose	Weight
		%	Lbs.
11W-45	5	18.1	3.31
A54-1		14.7	1.99
Difference		3.4	1.32
4W-34	7	18.7	3.25
A54-1		15.8	1.75
Difference		2.9	1.50
Balance	1.4*	17.1	3.35
A54-1		15.0	1.87
Difference		2.1	1.48

* This is an average for the balance (43 selections).

The total number of mother beets selected from the polycross test was 55. It can be seen that seven of these came from the progeny of 4W-34 and five from the progeny of 11W-45. From just the data of table 17 in those programs designed to take advantage of combining ability, there would be little choice between 11W-45 and 4W-34. However, on the basis of the data in table 16 showing that the progeny of 4W-34 averaged higher in percentage sucrose than those of 11W-45 and A54-1, it seems that 4W-34 should be favored. In evaluating the data in table 17, it should be kept in mind that the data for A54-1 is the average of that population for the unit in which the comparable selections were made and hence is of value primarily to make comparisons between the three groups; that is, for comparing the differences listed in table 17. Briefly, table 17 shows that the progeny of 11W-45 and 4W-34 have more individuals averaging higher in percentage sucrose than the balance of the population, and these individuals average approximately as high in weight per root.

From these results, it seems that 4W-34 and 11W-45 and their progeny should provide excellent material for making genetic studies pertaining to combining ability for weight per root and percentage sucrose. Such studies should provide information having a bearing on methods of breeding sugar beets. They should provide information as to how these individuals having superior combining ability can be employed to best advantage in the breeding program and to what extent the gains they represent can be utilized in commercial production of beet sugar.

Population Genetic Studies on the Total Nitrogen in Sugar Beets (Beta vulgaris L.)1/

The increased use of nitrogen fertilizers in the production of sugar beets has emphasized the importance of chemical genetic studies involving the amount of nitrogen in the "thin juice" obtained during the processing of the sugar beet in the manufacture of beet sugar.

Main effects

The means of the main effects are listed in table 18. The F values for populations and treatments compared with their respective F values at the 1-percent and 5-percent levels of significance reveal that there are significant differences between populations and between the two treatments. There are three levels of total nitrogen for populations. Populations A54-1 and A54-1BB compose the high level, 50-406 and 50-406BB the intermediate level, and the F_1 hybrid and 52-307 the low level. The data for 50-406, the F_1 hybrid, and 52-307 furnish evidence as to dominance relations in this cross. The average values for these three populations are 22.9, 15.6, and 14.8, respectively. Clearly, in the cross produced by hybridizing the two inbreds (52-406 and 52-307), on an average, higher total nitrogen in the thin juice is nearly if not completely dominant.

1/ This research is cooperative with Mrs. Merle G. Payne and Mrs. Grace W. Maag of the Chemistry Department of Colorado State University.

... r of mother beets ... the polycross test can ... e seen that seven ... from the progeny of ... of 11W-45. ... that the data of table 17 ... shows ... to take advantage of combining ability, ... would ... 11W-45 ... that ... progeny of ... averaged ... in percentage ... of 11W-45 ... that ... should be favored. ... data in table 17, it should be kept in mind ... average of that population for the ... which ... were ... and hence is of value primarily ... the three ... that is, for comparing the differences ... table 17 shows that the progeny of ... have ... averaging higher in percentage sucrose than ... and these individuals averaged approximately ... in weight.

... results, it ... and 11W-45 ... material for making genetic studies ... root and percentage ... studies ... having a bearing on methods of ... information ... to ... individuals having ... can be employed to best advantage ... the gains they represent ... utilized in ...

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... use of nitrogen fertilizers in the product ... of sugar ... sed the importance of chemical genetic ... involving the ... in ... "thin juice" obtained ... processing ... manufacture of beet sugar.

... the main effects are listed in table 18. ... values for treatments compared with their respective ... levels of significance reveal ... there ... significant ... populations ... between ... two treatments. ... Nitrogen for populations. Populations ... and ... level. 50-406 and 50-406H the intermediate level, ... 52-307 the low level. ... data for 50-406, ... hybrid, and ... as to dominance relations in this cross. The average ... three populations ... 22.5, 15.5, and 11.8, respectively ... cross produced by hybridization ... two inbreds (52-... ... average, higher total nitrogen in the thin juice is ... advent.

... is cooperative with Mrs. ... D. Payne and Mrs. Grace W. ... Chemistry Department of Colorado State University.

Table 18. Means for total nitrogen for populations, treatments, and populations X treatments.

Population	Treatment		Average
	Fertilized	Non-fertilized	
	mg	mg	mg
A54-1	46.8	18.8	32.8
A54-1BB	44.8	16.9	30.8
Average	45.8	17.8	31.8
50-406BB	33.6	12.6	23.1
50-406	31.2	14.6	22.9
Average	32.4	13.6	23.0
F_1 hybrid	21.3	9.8	15.6
52-307	18.6	11.1	14.8
Average	20.0	10.4	15.2
Grand average	32.7	14.0	23.3

<u>First and second order interactions</u>

The first order interaction of populations X treatments is shown in table 18. The differences between populations belonging to different levels of total nitrogen are greater on the fertilized plots than differences involving corresponding comparisons on the non-fertilized plots. For example, (45.8-20.0)-(17.8-10.4), giving a value of 18.4, is significantly different from zero. Similar comparisons within levels do not approach statistical significance; and the differences involved are of such small magnitude, comparatively, as to have little, if any, practical significance, even though the differences were statistically significant. Of considerable practical importance to a breeding program is the fact that the amount of total nitrogen for population A54-1 on the non-fertilized plots is not materially different from the amount of total nitrogen for the F_1 hybrid and 52-307 populations on the fertilized plots. That is, the values of 18.8, 21.3, and 18.6 are not significantly different. Hence, the differences due to treatments and differences due to populations are approximately of the same magnitude.

Such a finding lends considerable encouragement to the plant breeder, as it provides evidence that beets can be bred for either low or high nitrogen content. Further, it shows that in this study genetic control (represented by populations) of total nitrogen is of about the same magnitude as the environmental control (represented by the two fertilizer treatments).

The replications X populations X treatments means for total nitrogen are listed in table 19. For clarity in presentation, the data for eight contiguous replications are grouped and presented as averages. This makes five groups

for the 40 replications. The differences in total nitrogen between populations are greatest on the fertilized plots and for the replication group 33-40. In other words, the differences between populations are greatest for the replication group and fertilizer treatment having the highest concentration of total nitrogen in the thin juice. Another observation of interest is that on both the fertilized and non-fertilized plots the F_1 hybrid has more nitrogen in the thin juice, for those replication groups averaging more than 23 mg of total nitrogen (per 100 ml of thin juice), than does the inbred parent 52-307. The reverse is true for those replication groups averaging less than 23 mg of total nitrogen (see non-fertilized, table 19). That is, for the replication groups 1-8, 9-16, 17-24, and 25-32 on the non-fertilized plots, the F_1 hybrid has less total nitrogen than either inbred parent, 50-406 or 52-307. Thus heterosis for less nitrogen is occurring at the lower fertility levels.

Table 19. Means of total nitrogen per 100 ml for the interaction of replications X populations X treatments.

Treatment and population	Replication groups 1-8	9-16	17-24	25-32	33-40	Average
	mg	mg	mg	mg	mg	mg
Fertilized						
A54-1	38.53	34.99	38.83	45.90	75.79	46.81
A54-1BB	34.81	37.42	33.87	50.80	67.05	44.79
50-406BB	26.21	25.71	28.01	27.64	60.35	33.58
50-406	26.35	24.25	28.28	30.53	46.80	31.24
F_1 hybrid	17.41	17.86	18.83	20.32	32.23	21.33
52-307	14.05	16.12	17.36	19.90	25.71	18.63
Average	26.23	26.06	27.53	32.52	51.32	32.73
Non-fertilized						
A54-1	13.78	12.54	11.89	19.77	36.27	18.85
A54-1BB	12.54	13.15	12.50	17.46	29.04	16.94
50-406BB	8.92	10.87	9.31	11.08	22.92	12.62
50-406	10.96	11.29	10.52	14.66	25.39	14.56
F_1 hybrid	8.49	8.73	7.27	9.84	14.75	9.82
52-307	9.02	10.79	8.43	12.55	14.55	11.07
Average	10.62	11.23	9.99	14.23	23.82	13.98
Grand average	18.43	18.65	18.76	23.38	37.57	23.36

The greatest difference between populations within a fertilizer treatment (75.79-25.71) or 50.08 is greater than the greatest difference between fertilizer treatments within a population (75.79-36.27) or 39.52. The genetic difference represented by populations is larger than the environmental difference represented by treatments. Hence the means for the interaction of replications X populations X treatments support the deduction from the interaction of populations X treatments. These results provide convincing evidence that beets can be bred under the conditions of this experiment for either low or high nitrogen content in the thin juice. This is particularly true for the fertilized plots and for replications in which larger quantities of nitrogen are available to the sugar beet plant.

Frequency distributions

The obtained and calculated frequency distributions, differences, and proportions of genetic deviates expected are listed in table 20. The total number of genetic deviates expected in the lower classes of table 20 are listed in the second to the last column and those in the higher classes of table 20 in the last column. The standard error of the binomial distribution may be used to determine whether the populations differ as to number of genetic deviates in the lower classes and the higher classes. Also, homogeneity chi square can be employed for this purpose and perhaps is both easier to apply and more comprehensive.

t difference between populations within a fertilizer ...) or 50.08 is greater than the greatest difference between ... within a population (75.79-26.27) or 49.52. The genetic ... ted by populations is wider than the environmental differ... ted ... treatments. ... the means for the interaction of X populations X treatments support the deduction from the inter... tions X treatments. These results provide convincing evidence ... s bred under the conditions of this experiment ... either low ... content in ... thin juice. This is particularly ... and for replications in which larger quantities of nitro... to the sugar beet plants.

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... and calculated frequency distributions, ... genetic deviates expected are listed in table 20. The total ... deviates expected in the lower classes of table 20 are listed ... last column ... those in the higher classes of table ... The standard ... of the binomial distribution ... whether the populations differ as ... number of genetic ... lower classes and the higher classes. ... be employed for this purpose ... perhaps is both easier to apply ... ive.

Table 20. Obtained and calculated frequency distributions and differences and proportions of individuals in the lower classes and in the higher classes expected to be genetic deviates for total nitrogen; data converted to logarithms, fertilized and non-fertilized plots, and segregating populations.

Treatment, population and distribution	Upper limit of class (mg per 100 ml) and logarithms																				Genetic deviates	
	(0 to 7) 0 to 0.8451	(14) 1.1461	(21) 1.3222	(28) 1.4472	(35) 1.5441	(42) 1.6232	(49) 1.6902	(56) 1.7482	(63) 1.7993	(70) 1.8451	(77) 1.8865	(84) 1.9243	(91) 1.9590	(98) 1.9912	(105) 2.0212	(112) 2.0492	(119) 2.0755	(126) 2.1004	(133) 2.1239	(140) 2.1461	Lower values	Higher values
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Fertilized																						
A54-1																						
Obtained		9	31	44	48	34	32	31	18	18	7	14	8	6	11	4	3		1	1	84	73
Calculated		1	11	38	61	62	52	36	24	14	9	5	3	2	1	1	0		0	0	50	35
Difference		[illegible]	20	6						4	-2	9	5	4	10	3	3		1	1	34	38
Proportion		0.89	0.65	0.14						0.22		0.64	0.62	0.67	0.91	0.75	1.00		1.00	1.00	0.40	0.52
A54-1BB																						
Obtained		12	29	42	47	48	37	32	12	14	13	7	8	5	6		2	3	1	2	41	61
Calculated		1	13	44	67	64	50	33	21	12	7	4	2	1	1		0	0	0	0	14	27
Difference		11	16							2	6	3	6	4	5		2	3	1	2	27	34
Proportion		0.92	0.55							0.14	0.46	0.43	0.75	0.80	0.83		1.00	1.00	1.00	1.00	0.66	0.56
50-406BB																						
Obtained	1	31	80	66	42	25	19	9	12	8	[illegible]	1	6	2	5		2	1	1	1	112	56
Calculated	0	5	55	101	82	44	20	8	3	1	1	0	0	0	0		0	0	0	0	60	13
Difference	1	26	25					1	9	7	7	1	6	2	5		2	1	1	1	52	43
Proportion	1.00	0.84	0.31					0.11	0.75	0.88	0.88	1.00	1.00	1.00	1.00		1.00	1.00	1.00	1.00	0.46	0.77
Non-fertilized																						
A54-1																						
Obtained	21	138	90	31	9	7	4	5	5	1	2	1	2	2		2					159	31
Calculated	4	124	134	45	10	2	1	0	0	0	0	0	0	0		0					128	3
Difference	17	14				5	3	5	5	1	2	1	2	2		2					31	28
Proportion	0.81	0.10				0.71	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00					0.19	0.90
A54-1BB																						
Obtained	22	141	92	35	16	2	2	2		2	3			2		1					22	30
Calculated	6	145	126	34	7	2	0	0		0	0			0		0					6	9
Difference	16				9	0	2	2		2	3			2		1					16	21
Proportion	0.73				0.56	0	1.00	1.00		1.00	1.00			1.00		1.00					0.73	0.70
50-406BB																						
Obtained	55	199	40	7	[illegible]	4		1		2	1	1	1	1							55	26
Calculated	30	231	55	4	0	0		0		0	0	0	0	0							30	4
Difference	25			3	8	4		1		2	1	1	1	1							25	22
Proportion	0.45			0.43	1.00	1.00		1.00		1.00	1.00	1.00	1.00	1.00							0.45	0.85

There are no significant differences between populations as regards the number of genetic deviates in the higher classes (last column of table 20). However, the numbers of genetic deviates in the higher classes for both treatments and all populations are significantly different from zero.

Turning to a consideration of differences between populations for the lower classes (second to the last column of table 20), there are significant differences between fertilizer treatments and between populations for both fertilizer treatments. The non-fertilized plots are lower in number of genetic deviates. These data furnish some evidence that breeding for low nitrogen at the higher fertility level would be more effective. A54-1BB is lower in genetic deviates than either of the other two populations. Again, all of the numbers of genetic deviates are significantly different from zero for all populations in both treatments.

From these considerations, breeding within these three populations for either low, intermediate, or high nitrogen would be expected to result in some genetic improvement and would be more effective at the higher fertility level.

The proportions of genetic deviates in the different classes should be considered in selecting individuals for further breeding. This is particularly true if selection is employed as the breeding method. Those classes having 100 percent genetic deviates would be of particular interest, as they allow the identification (within reasonable limits) of the genetic deviates. A progeny test is required to identify the genetic deviates selected from those classes having less than 100 percent genetic deviates. Of course, those individuals selected from classes showing 100 percent genetic deviates should be progeny tested also, as occasionally chance environmental deviates would be expected to occur among them.

An examination of the frequency distribution of the genetic deviates for population A54-1 reveals that this frequency distribution has a mode among the lower deviates and another among the higher deviates. These modes have upper class limits of 21 and 105, respectively. Such being the case the mean total nitrogen for each of these two groups can be estimated. The procedure will be illustrated for the lower classes. The class centers may be obtained by dividing the class interval 7 by 2 (equals 3.5) and adding this value to the value for the immediately preceding class. By so doing, the class centers are 10.5, 17.5, and 24.5. The frequencies for these classes taken from table 20 opposite row heading differences are 8, 20, and 6, respectively. Multiplying the class centers by their respective frequencies and summing, we have [(8 X 10.5)+(20 X 17.5)+(6 X 24.5)], and this divided by 34 equals 17, the mean for the lower classes. Similarly, the mean for the higher classes is estimated as 94. It should be possible to obtain, by breeding, a population having a mean of 17 and another population having a mean of 94. The latter population would have 5 times as much total nitrogen as the former. The mean of population A54-1 for the fertilized plots, as shown in table 3, is 46.8. The decrease in total nitrogen for the first population is 275 percent, and the increase for the second population is 201 percent.

PART VIII

RHIZOCTONIA INVESTIGATIONS

Inoculation Techniques and Selecting for Resistance

Foundation Project 25

J. O. Gaskill V. G. Pierson

Research conducted in cooperation with the Botany and Plant Pathology Section, Colorado Agricultural Experiment Station.

PROGRESS REPORT ON RHIZOCTONIA RESISTANCE BREEDING INVESTIGATIONS, FORT COLLINS, COLORADO, 1958 1/

(A phase of Beet Sugar Development Foundation Project No. 25)

John O. Gaskill and Victor G. Pierson 2/

In a progress report for 1957 3/, rather convincing evidence of the existence of a moderate degree of Rhizoctonia resistance was shown for certain strains and classes of sugar beet material, by means of a post-thinning inoculation technique. Inoculum applied with the seed at time of planting caused almost complete killing of all strains tested, largely before emergence, precluding any reliable comparisons between strains or classes of material by that method. Experimental work conducted during 1958 included further studies on both these inoculation techniques, with special emphasis on regulation of intensity of disease exposure; exploratory trials with other inoculation methods; tests of a series of Rhizoctonia isolates for pathogenicity; and progeny tests for Rhizoctonia resistance. All field studies were located on the Hospital Farm near Fort Collins, Colorado, and greenhouse work was performed on the C.S.U. campus. Only highlights of experimental work and results will be presented in this report.

Progeny Tests

Two progeny tests were conducted in 1958 primarily to appraise the effectiveness of selection for resistance under Rhizoctonia exposure created by application of inoculum with the seed at planting time. Roots selected for resistance from two commercial varieties in the fall of 1956 were halved and brought to seed in isolated seed plots in 1957 — one seed plot for each variety. The open-pollinated seed from each original root was termed a progeny.

1/ Cooperative research conducted by the Crops Research Division, A.R.S., U.S.D.A., and the Botany and Plant Pathology Section, Colorado Agricultural Experiment Station, supported in part by funds contributed by the Beet Sugar Development Foundation and the Great Western Sugar Company.

2/ Plant Pathologist, U.S.D.A., and Graduate Research Assistant, Colorado Agricultural Experiment Station, respectively.

3/ Sugar Beet Research, 1957 Report: pages 119-123 (compiled by the Sugar Beet Section, Crops Research Division, ARS, USDA; CR-2-58).

In one test (R-4), 14 progenies of roots selected from GW 359-53R were compared with the parental variety. In the other test (R-5), 14 progenies from the leaf spot - black root resistant variety, US 401, were compared with the latter variety. Three check varieties were common to both tests. In each test, any given progeny or check variety occurred in 9 sub-plots (each 1 row x 17') — 3 sub-plots non-inoculated, 3 inoculated at planting time (inoculum applied with the seed), and 3 inoculated 4 to 5 days after thinning. The parental variety in each test occurred as 3 entry numbers, thus having 3 times as many sub-plots in each inoculation category as for any one progeny.

Inoculations in experiments R-4 and R-5 of 1958 were performed in the same manner as in experiment R-2 of the preceding year (see 1957 report). In 1958 the inoculum was prepared as a composite of Rhizoctonia isolates known to be pathogenic to sugar beets. A set of 13 such isolates was chosen for this purpose from a total of 25 isolates tested for pathogenicity under greenhouse conditions. Thus the 1958 inoculum was considered more virulent than that used in the preceding year which was a composite consisting largely of untested isolates. Rates of application of inoculum (dried, ground barley cultures) in the two 1958 progeny tests were as follows: (1) with the seed — 5 ml. per 17' of row (about one-third the rate used in 1957); and (2) post-thinning — 1 ml. per plant in certain replications and 2 ml. per plant in others (1957 rate, 2 ml.).

In each 1958 test, inoculum applied with the seed resulted in almost complete kill — largely before emergence — in each progeny, in the parental variety, and in each check variety. There was no evidence of differing degrees of resistance among the entries in either test.

In the plots inoculated post-thinning, plants surviving on September 24 (51 days after inoculation) amounted to 1.8% for the parental variety, GW 359, and 2.0% for its 14 progenies (exp. R-4). Corresponding survival figures for US 401 and its progenies were 0.6% and 0.6%, respectively (exp. R-5). Differences among the entries within each test appeared to be negligible, insofar as measured by the September 24th survival counts.

Two of the check varieties, Acc. 1208 and 1353, occurring in each of the above 1958 progeny tests, had been chosen as susceptible and relatively resistant, respectively, on the basis of results obtained from post-thinning inoculation in 1957 experiment R-2. The two strains had differed quite significantly in resistance in that test but suffered complete kill in 1958 tests R-4 and R-5 with the same inoculation method. They also were completely killed in the 1958 tests by inoculum applied with the seed.

From the results presented above, it is apparent that disease exposure in the two 1958 progeny tests was much too severe for satisfactory appraisal of resistance. This conclusion spot-lights the need for suitable means of controlling intensity of Rhizoctonia exposure. Results of studies on that subject, conducted during 1958, are presented below.

Intensity of Rhizoctonia Exposure

Inoculum Applied with Seed:

A field experiment, designated R-1, was designed to study effects of kinds of inoculum and rates of application with the seed at time of planting. This experiment involved (1) two pathogenic isolates of Rhizoctonia, used separately; (2) two kinds of inoculum substrate (barley and grain sorghum); (3) three rates of application (1/2 ml., 2 ml., and 5 ml. per 17' of row); (4) check treatments of three kinds; (5) split-plot design with 3 replications; and (6) one sugar beet variety (GW-359). Inoculum was prepared in dried, ground form, and was distributed uniformly on top of the seed on the planter belt. The seed was treated with maneb and the amount to be planted was accurately weighed for each plot (2.5 g. per 17' of row). Stands were not thinned artificially, and final population counts were made on September 19, 53 days after planting and inoculation.

The highlights of this experiment, insofar as rates are concerned, may be summarized as follows: (1) Losses in stand, attributable to the application of barley-type Rhizoctonia inoculum, averaged 79.2%, 97.6%, and 97.7% for the 1/2-ml., 2-ml., and 5-ml. rates, respectively; and (2) corresponding stand losses shown for the 3 rates of sorghum-type inoculum were 71.1%, 90.0%, and 96.2%. With each type of inoculum, the difference between the 1/2-ml. and 2-ml. rates, in average stand loss, was highly significant. Plots receiving 2-ml. applications of killed Rhizoctonia inoculum (barley- and sorghum-types, respectively, the fungus having been killed with propylene oxide) showed an average stand loss of 16.2%. Plots receiving 2-ml. applications of ground, autoclaved substrate (barley and sorghum, respectively) showed an average loss of 60.5%. All percentage-loss figures given in this paragraph are based on average plant survival (122.8 plants per plot) recorded for the non-inoculated check treatment — the treatment involving no barley or sorghum applications of any kind.

On the basis of these results, it appears that, under similar conditions and with inoculum of equal virulence, no more than 1/2-ml. of inoculum (per 17' of row) should be used for Rhizoctonia resistance testing of currently available sugar beet strains or progenies by this method. Presumably such a level of disease exposure would be too mild, however, for selection purposes, due to the high percentage of escapes expected.

Post-thinning Inoculation (Age of Plants):

In view of the encouraging results obtained from post-thinning inoculation in 1957, an experiment was conducted in 1958 in order to study the relation of plant age to Rhizoctonia attack. This experiment (#R-2) involved four dates of planting for a single variety (GW 359), with all inoculations performed on a single date. Composite, barley-type inoculum, like that used in experiments R-4 and R-5, was employed in the usual way (2 ml. per plant placed around the tap root, about 1" to 1 1/4" below the soil surface, with soil replaced to the original depth). A split-plot design with four replications was used, with individual sub-plots two rows wide and 12' long. Thinning (approximately 8" to 9" spacing) was performed at about the 4- to 6-leaf stage. Initial and thinned stands were good, but all plants with obvious curly top were removed just before the inoculation date, thus reducing stands substantially in the earliest planting. It is felt that the outcome of the experiment was not affected materially by this loss of stand.

Results of experiment R-2 are presented in Table 1 and Figure 1. These results — particularly the survival percentages for treatment no. 21 on September 27 — clearly show an inverse relationship between the severity of Rhizoctonia attack and the age of plants at time of inoculation. It is believed that this information can be put to good use in future resistance tests.

Other Post-thinning Inoculation Trials:

Preliminary, 1958 field and greenhouse studies on rate of application of inoculum by means of the sub-surface, post-thinning method described above, failed to show that satisfactory control of intensity of Rhizoctonia exposure can be achieved by regulating the amount of inoculum. Additional information on this point is needed.

Another post-thinning inoculation method, used on an exploratory basis in 1958, seems at present to offer considerable promise. This technique involves the placement of dried, ground, barley inoculum in the center of the foliar rosette, allowing it to fall to the soil below at will. The soil around the plant is not disturbed and the inoculum is not

Figure 1. General view of Rhizoctonia inoculation experiment R-2, Hospital Farm, Fort Collins, Colorado, August 13, 1958, 12 days after post-thinning inoculation. Plots are 2 rows x 12'. The 4 plots shown in foreground are as follows, left to right (short stake in left-hand row of each plot):

Plot no.	Date of planting	Date of thinning	Days from thin. to inoc.(no.)	Inoculation treatment No.	Inoculation treatment Description
1*	6/27	7/21	11	21	Living Rhizoc. inoculum
2	6/27	7/21	11	23	Control (non-inoculated)
3	6/27	7/21	11	22	Killed Rhizoc. inoculum
4*	6/13	7/10	22	21	Living Rhizoc. inoculum

* Plots of chief interest (marked by tall, white stake at far end of each row). Note that nearly all plants are dead in plot 1, as contrasted with the older plants (plot 4) in which dying has just begun.

A buffer of 2 rows occurs between plots 3 and 4, separating dates of planting.

Table 1. Severity of Rhizoctonia attack as influenced by age of plants at time of inoculation. Hospital Farm, Fort Collins, Colorado, 1958 — experiment R-2 (Results given as 4-plot averages).

Inoculation Treatment								
No.	Description	Planting date	Thinning date	Days a/ from thin. to inoc.	Plants b/ per plot 8/5	Survival c/ 8/19	Survival c/ 9/27	Disease d/ rating (living plants, 9/27)
				No.	No.	%	%	
21	Living Rhizoc. inoculum	7/3	8/1	0	27.0	5.9	0.0	—
		6/27	7/21	11	29.3	8.6	0.8	5.0
		6/13	7/10	22	25.3	83.0	2.1	4.5
		5/22	6/18	44	18.5	98.6	26.9	4.5
22	Killed Rhizoc. inoculum e/	7/3	8/1	0	29.5	100.0	97.8	1.2
		6/27	7/21	11	32.3	100.0	100.0	1.1
		6/13	7/10	22	26.8	100.0	100.0	1.3
		5/22	6/18	44	16.3	100.0	97.7	1.2
23	Control (non-inoculated)	7/3	8/1	0	30.3	100.0	100.0	1.1
		6/27	7/21	11	31.0	99.2	99.2	1.1
		6/13	7/10	22	23.5	100.0	100.0	1.1
		5/22	6/18	44	19.0	100.0	100.0	1.0

a/ Date of inoculation was 8/1. On that date, plants in non-inoculated plots were treated mechanically in the same way as the plants in other plots, except for omission of inoculum .

b/ Numbers given represent total inoculated plants, since dying as a result of inoculation had not begun by 8/5.

c/ Living plants, on date indicated, expressed as percentage of 8/5 population.

d/ Basis of ratings, pertaining to apparent Rhizoctonia attack: 1 = essentially healthy; 5 = very severe disease (plant nearly dead).

e/ Inoculum was prepared as for treatment 21, but Rhizoctonia subsequently was killed by propylene oxide and autoclaving.

covered. Light sprinkling of the field — usually once daily — for a period of about 10 days after inoculation is used to maintain favorable soil moisture at or near surface. This method was used at three rates on one inbred line in 1958, with complete kill. This technique would be much more economical than the older post-thinning inoculation method described above, and the absence of any form of mechanical injury to the plant might also be advantageous. However, no evidence has been obtained thus far as to whether this procedure can be used satisfactorily to appraise differences in Rhizoctonia resistance.

Tentative Plans for 1959

A number of seed lots obtained in 1958, from plants selected under artificial Rhizoctonia exposure (largely post-thinning inoculation) in 1957, are on hand. One of those seed lots currently is being used, together with other material, in a greenhouse, Rhizoctonia-resistance study dealing with the interaction of plant ages, sugar beet strains, and fungus isolates. It is proposed to use all or at least a substantial number of the 1958 seed lots in Rhizoctonia-resistance field studies during 1959 — studies utilizing some of the information gained in 1958 pertaining to regulation of intensity of disease exposure. The course of greenhouse work in 1959 will depend in part on the outcome of the experiment now under way.

Roots selected in 1958, under the severe Rhizoctonia conditions created in experiments R-4 and R-5, plus certain other selections, will be brought to seed in 1959.

PART IX

DEVELOPMENT OF BASIC BREEDING MATERIAL

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GREENHOUSE SCREENING TESTS FOR BLACK ROOT RESISTANCE

Foundation Project 26

G. E. Coe C. L. Schneider

DEVELOPMENT OF BASIC BREEDING MATERIAL

(Foundation Project 26)

by G. E. Coe

In this part of the report the advances that have been made in interspecific hybridizations, polyploidy, induced mutations, chemical treatments for pollen sterility, and disease resistance of primary monogerm breeding material will be presented. However, greater effort and more time have been devoted to the development of breeder seed and elite strains that have been included in various evaluation tests reported in Part X.

Tests with Gametocide FW-450

The discovery by F. M. Eaton that sodium 2,3-dichlorisobutyrate, designated FW-450 by Rhom and Hass, suppressed pollen production in cotton has presented the possibility of using the chemical to bring about commercial production of hybrid seed with crop plants which previously were not considered amenable to this type of varietal improvement. Preliminary tests were conducted on sugar beets at Beltsville in the winter of 1957-1958. Sixteen sugar beets with seed stalks were divided into four groups, and each group was sprayed just before anthesis with a different concentration of FW-450 solution. The concentrations used were 0.25, 0.50, 1.0, and 2.0 percent. The 2.0 percent solution caused some burning of the leaves and considerable injury to the flowers. It was noted that a small amount of pollen was produced at anthesis by the plants sprayed with the 0.25 percent solution, while no pollen was produced at anthesis by the plants sprayed with the solutions of higher concentrations. The reduction in the amount of pollen production following treatments, the length of time before some pollen production was resumed after treatment, and the extent of injury to the plants were all directly related to the concentration of the solution.

In the spring of 1958 a more extensive test of the chemical was made in an isolated plot in which red beets were planted in a row on the windward side. In an adjacent row 60 roots of SP 5481-0 were planted in 6 sections of 10 roots each. Each of the six sections was given a different treatment. The first section of the row was the untreated check. The second section was sprayed with 0.50 percent solution of FW-450; the third section, with 0.75 percent solution; the fourth, with 1.0 percent solution; the fifth, with a 1.25 percent solution; and the sixth, with a 1.5 percent solution. The plants were sprayed to runoff wetness before any flowers had opened. Individual plants were sprayed only once. In order to treat the plants in the proper stage of development, it was necessary to spray at two different dates, the late-bolting plants being sprayed 16 days after the early-bolting ones. The plants received no further treatment. Seed was harvested from each plant individually; then it was threshed, cleaned, and weighed. Germination tests

were run on the seed of each individual plant. From each seed lot saucers of 50 seedballs each were planted for germination tests, and one additional saucer was sown broadcast for the purpose of giving a large number of seedlings from which to determine the percentage of hybrids. The total number of seedlings obtained in this manner from each plant in each of the treatments were 6,400, 4,371, 3,833, 4,629, 3,834, and 4,001 for 0 percent, 0.50 percent, 0.75 percent, 1.0 percent, 1.25 percent, and 1.50 percent solutions, respectively. In Table 1 the results are given showing the effect of the treatments on seed production, seed germination, the percentage of hybridization, and the number of hybrid plants obtained from 100 seedballs.

Table 1. Results of treatments with FW-450.

	Concentration of FW-450 in percent					
	Untreated	0.50	0.75	1.0	1.25	1.50
Weight of seed (grams)	122.50	75.50	79.45	77.23	67.86	39.17
Germination (percent)	87.40	76.40	67.22	66.89	61.57	52.50
Hybrids (percent)	35.76	44.04	56.67	35.82	31.74	41.29
No. hybrids per 100 seedballs	69.00	63.10	69.60	33.70	33.30	31.30

From the data given in Table 1 it can be seen that treatments with FW-450 caused a reduction in the average yield of seed per plant and a reduction in germination. The chemical had a toxic effect that was quite severe at 1.5 percent concentration. The large percentage of hybrids in the untreated check was somewhat unexpected, since it was assumed that the amount of pollen from the red beets reaching the untreated plants of SP 5481-0 in Section 1 of the treated row would be relatively small in comparison with the abundance of pollen from the plants within the section. Although there was a slight increase in the percentage of hybrids from plants treated with low concentrations of FW-450, there was a slight decrease in the percent of hybrids at higher concentrations, indicating that under the conditions of this test the chemical did not greatly affect the amount of hybridization. Considering the effect of FW-450 on seed production and on seed germination, it seems that in further experiments with FW-450 at the Plant Industry Station solutions of less than 1 percent should be used. In this test FW-450 was not consistently effective in bringing about increased hybridization.

Progress of a Species Hybrid

Significant progress has been made in one interspecific Beta hybrid at the Plant Industry Station. F_1 plants of *B. trigyna* 2n = 36 (*B. corolliflora*) pollinated with pollen from tetraploid sugar beets have been backcrossed using *B. corolliflora*

as the recurrent backcross pollinator. Seventeen healthy, vigorous backcross plants were brought to flower in 1958. Six tetraploid sugar beets and one tetraploid Swiss Chard plant were placed among the backcross plants so that crossing might occur. Seeds were produced on all the plants but were rather sparce and inviable on the backcross plants. The progeny of plants of the backcross parent, totaling 262 seedlings, are growing in the greenhouse. Although many of these plants appear to be quite similar to _B. corolliflora_, others show morphological characters indicating that they contain sugar beet chromosomes. Of more importance, however, are the progeny of plants of tetraploid sugar beet and Swiss Chard which were grown in the isolation. There appears to be individuals in the progeny of these plants which are the product of pollination by the backcross parent. After chromosome counts are made and the plants have been observed during advanced phases of growth, a more positive statement in regard to parentage can be made. It seems that the continuation of this breeding problem will proceed without great cytological difficulty and that chromosomal material from _B. corolliflora_ will be introduced into the sugar beet. This line of breeding offers possibilities of a new source of germplasm.

Status of Breeding with Irradiated Material

Seed of six monogerm lines were given thermal neutron irradiation and grown in the nursery test of 1957. Selected plants from these lines were hybridized in 1958 with plants from nonirradiated monogerm lines. Seed set on the plants grown from irradiated seed was quite poor, and germination of the seed was rather low. Some F_1 plants from this cross are now growing in an overwintering plot, and F_2 seed will be obtained in 1959. The F_2 progeny will be tested in 1960 in an attempt to find beneficial mutations.

Studies of mutations induced by thermal neutron irradiation have been conducted with an annual beet. Three recessive leaf characters have been isolated in true breeding lines. Plants with these characters were outcrossed to normal-appearing plants of the parental annual line. Paired crosses of F_1 plants were made in bags in the greenhouse. The mutant characters segregated in the F_2 progenies in varying ratios. For one of the mutant characters the F_2 progeny from a particular cross gave a ratio of one mutant to one normal; but another F_2 progeny from this same original mutant gave a segregation ratio of 1:12. Other F_2 progenies ranged between these extremes. The ratios of the recovered mutant character in the F_2 progenies from the other two mutant characters also varied. On the basis of the variation of the ratio of recovery of the mutant type in the F_2 progenies, a single-factor inheritance cannot be postulated. These interesting segregation ratios in annual beets have considerable theoretical interest.

Polyploidy

In the 1957 report several lines were mentioned from which tetraploids are being produced. The problem is to eliminate from these lines all plants which give irregular chromosome segregation. A multigerm variety, SP 5481-0, that is resistant to black root and leaf spot has been added to the polyploid program. Except for the "O" types, the available monogerm lines do not have sufficient production potential to justify entering them into the polyploid program.

From colchicine treatments there are now on hand 7 lbs. of SP 5875-0, which was developed from SP 5553-0, a variety resistant to curly top and leaf spot. This tetraploid line, however, is still unstable, giving an undetermined degree of aneuploidy.

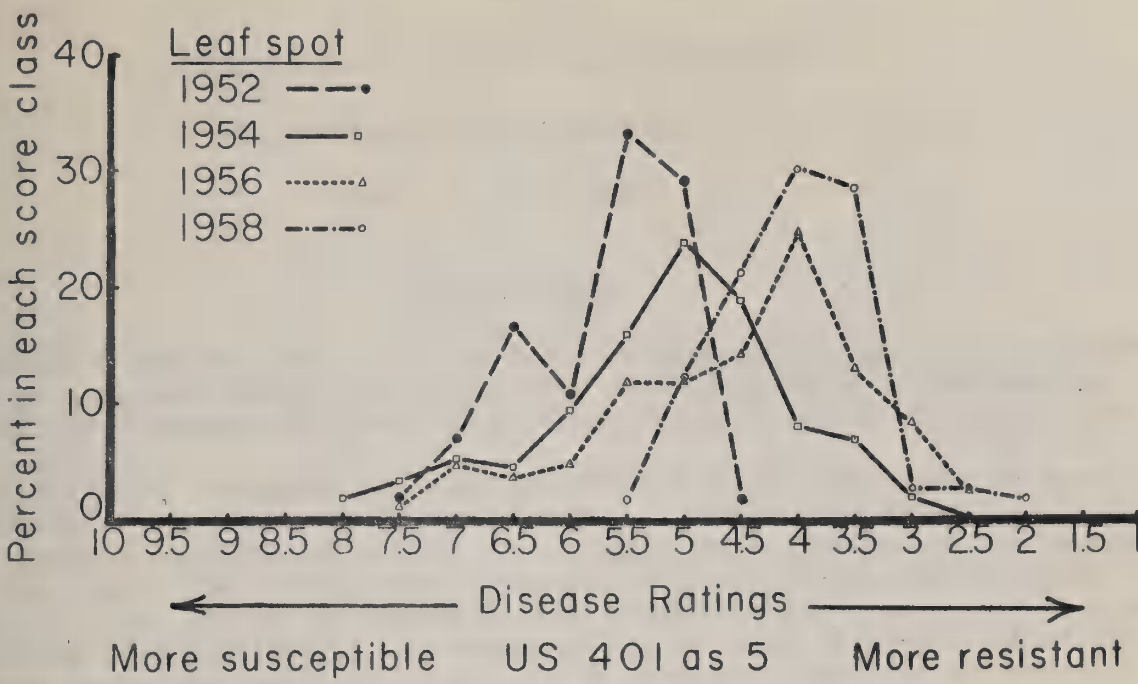
Chromosome counts in colchicine-induced tetraploid lines of sugar beets have shown that all the lines are continuing to produce up to 35 percent aneuploid plants in subsequent generations following treatment, even though the seed plots are rogued to tetraploid plants. An unstable tetraploid line should not be used with the expectation of obtaining an accurate test of the value of triploid sugar beets since it is well known that aneuploid plants are generally inferior to euploid plants.

Improvement of Monogerm Lines in Resistance to Leaf Spot and Black Root

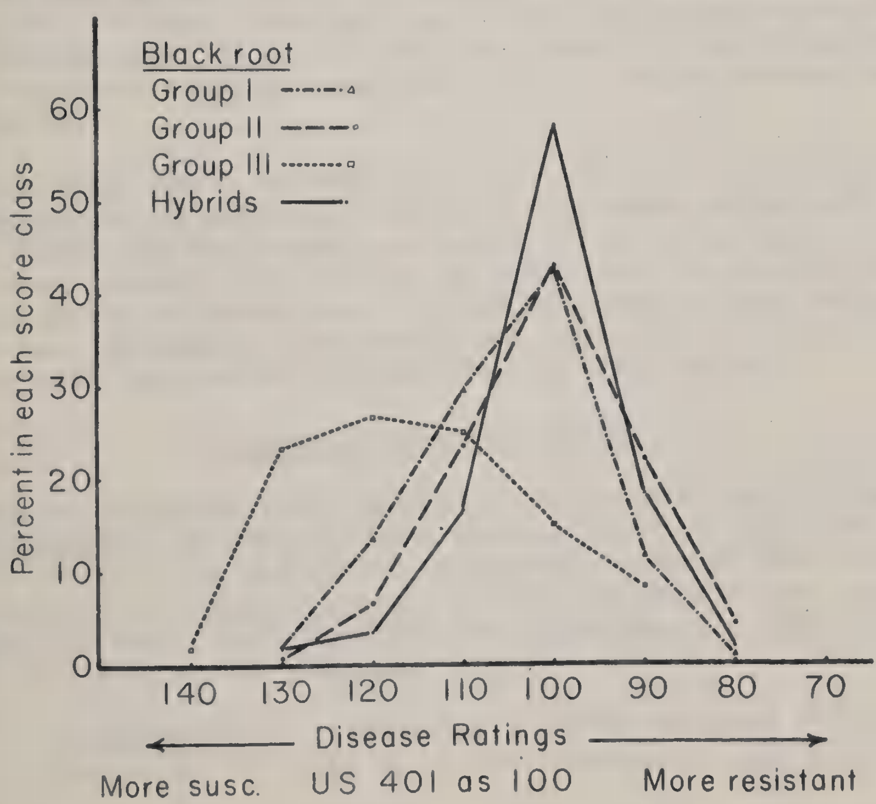
A brief summary of the improvement of monogerm lines in resistance to leaf spot is presented in Graph I. This graph shows the percentage of the total number of monogerm progenies tested in 1952, 1954, 1956, and 1958 that fell into each category of leaf spot damage. The commercial multigerm US 401 is used as one of the check varieties and in the graph is arbitrarily given a value of 5. When US 401 has a rating of 5, the susceptible check has a rating of about 8; and the highly resistant US 201 has a rating of about 1. The data for the 1952 progenies are comparisons with US 226 as check variety, but US 226 has about the same resistance to leaf spot as US 401. It can be seen that there has been improvement in the level of leaf spot resistance from 1952 to 1958. The 1954 monogerm seed lots were almost equal to US 401 in leaf spot resistance. The 1958 seed lots were definitely superior to US 401.

Until recently only field trials were used to evaluate breeding material for black root resistance. These trials were always complicated by a lack of uniformity of disease exposure, environmental factors, and certain attributes of the lines being tested. A greenhouse test developed by C. L. Schneider is now being used to screen breeding materials for resistance to black root. The test is not complicated by the many factors inherent in field testing. In 1958 greenhouse screening tests were made on three types of monogerm progenies and on a group of monogerm hybrids. The results are shown in Graph 2.

The first group of monogerms consisted of 104 progenies from unselected monogerm roots that had been recovered from the backcrossing program. The second group of monogerms consisting of 123 progenies had two generations of selections since the last backcross. The third group of monogerms consisted of 60 progenies that had one generation of selection since the last backcross. These selections are considered to be second-choice selections, the first-choice selections being those from which the second group of monogerms was derived. The percentage of progenies in each of these groups that fell into the different disease-rating classes are shown in Graph 2. The third group of monogerm progenies, which had less selection for black root resistance than the second group of monogerms and also less backcrossing than the first group, had far less resistance to the disease. The second group of monogerm progenies, which were of a better type and which also had one more generation of selection than the third group, had reasonably good resistance to black root. The first group of monogerms shows that considerable resistance may be attained by backcrossing without selection.



Graph 1. Leaf spot readings of monogerm breeding material. Plant Industry Station.



Graph 2. Distribution of monogerm lines and hybrids in black root screening tests.

SCREENING TESTS FOR BLACK ROOT RESISTANCE

(Foundation Project 26)

by C. L. Schneider

General Methods

In greenhouse screening tests for resistance to Aphanomyces cochliodes zoospore inoculum is employed because it insures uniform disease exposure and permits testing of large numbers of plants in a relatively small space and short time.

Large quantities of zoospores are readily obtained in the laboratory by growing pure cultures of the fungus in flasks of nutrient broth, made by boiling 50 grams of maize kernels per liter of water. After about one week's growth the mycelial mats of the fungus are rinsed, then submerged in flasks of sterile tap water overnight at about 20° C. As a general rule about 6 mycelial mats, one from each of six 250 ml. broth cultures, are submerged in one liter of water. About 12 hours later large quantities of zoospores are obtained, sometimes as many as 100,000 per ml., as determined with a haemocytometer.

In greenhouse inoculation tests 25 sugar beet seedballs previously treated with a fungicide are planted in circular rows at a uniform depth in a 6-inch saucer of steamed soil. When emergence is complete, seedlings are singled and are inoculated by delivering an aqueous suspension of zoospores with a 50 ml. pipette. The calculated number of zoospores introduced per saucer has varied from 300,000 to 1,000,000, depending upon the age of the plants and the prevailing greenhouse temperature. Blackroot severity generally increases with temperature and decreases with age of plants.

Greenhouse inoculation tests are made throughout the year. During the cooler seasons the greenhouse is maintained at 75° F. to insure adequate black root development. During the hot summer months the effect of excessive greenhouse temperatures which increase the severity of black root is compensated to some degree by using lower concentrations of zoospore inoculum than during the cooler months. There are included in each black root test, for purposes of comparison, a resistant variety, such as US 400, and a susceptible variety.

Greenhouse Screening Tests

In 1958 greenhouse screening tests were made to determine the relative susceptibility to Aphanomyces of the following general types of seed lots: A. Sugar beet seed lots developed in the current breeding program at the Plant Industry Station. B. Seed lots of Beta vulgaris, chiefly culinary forms, including: Accessions from the Ames, Iowa, Regional Plant Introduction Station of seed introductions from Asia and Africa; and seed lots from local seedsmen.

The results of the greenhouse screening tests of the monogerm and monogerm hybrid lines are presented in Graph 2, p. 192. Among the seed lots developed

at the Plant Industry Station, including several monogerm lines, were a number that were classified as more resistant than the commercial resistant check variety (Fig. 1).

The results of the greenhouse tests were shown to be indicative of results when the lines are grown in field plots naturally infested with Aphanomyces cochloiodes. In the summer of 1958 276 of the monogerm lines tested in the greenhouse and 52 of the monogerm hybrids were grown in field plots at the Plant Industry Station, exposed to a natural epidemic of black root that virtually eliminated plots of the susceptible check variety. The correlation coefficient between the greenhouse susceptibility ratings and root weights of lines grown in the field plots was .338**, which indicates a significant association between the reaction of the lines to Aphanomyces in the greenhouse and in the field.

Wide differences in reaction to Aphanomyces were shown among the Beta vulgaris accessions from the Plant Introduction Station (Fig. 2). The majority were considerably more susceptible as compared with the resistant check variety and as compared with most of the lines developed as black root resistant at the Plant Industry Station.

Improvement of Black Root Resistance by Greenhouse Selection

Preliminary tests indicate that black root resistance can be improved through the selection of the relatively few outstanding plants which recover and make thrifty growth under severe greenhouse exposure to Aphanomyces. Polycross progenies of selected plants were inoculated in the greenhouse together with the mother lines. In one group selected from 4 multigerm lines inoculated in cold frames 47 % of the progenies were more resistant than the mother lines, and 11% were susceptible. In another group selected from US 400 in greenhouse inoculation tests 50% of the progenies were more resistant than the mother line and only 5% were more susceptible, indicating the possibility of increasing resistance through seedling selection in greenhouse tests. Further experiments coupled with field tests are now in progress to explore more fully the possibilities of improving black root resistance by this method.

Pathogenicity of Aphanomyces cochlioides

Studies have been continued to determine the existence of pathogenic races of the blackroot fungus A. cochlioides. Several varieties of sugar beet and other hosts were inoculated with isolates of the fungus from different localities and from different hosts. Although there are differences in virulence among the isolates, there were no variety-isolate interactions to indicate pathogenic races.

Since the occurrence of pathogenic races could greatly affect the program of developing black-root-resistant sugar beet varieties and since the results of the present investigations do not necessarily eliminate the possibility of their existence now or in the future, studies are being continued on physiologic specialization of the fungus.

lar Industry Station, including several ... lines, we ... e classified as more resistant than the commercial ... check variety.

... ults of the greenhouse tests ... are grown in field plots naturally infested ... cochlioides. ... of 1958 S/6 ... ges. Hybrids were grown in field plots ... to a natural epidemic of black root ... check variety. ... ity ratings and root ... lines ... which indicates a significant ... in the greenhouse and ...

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... provement of Black Root Resistance in Greenhouse ...

... tests indicate that black root ... the relatively few outstanding ... Severe greenhouse exposure to Aphanomyces ... lants were inoculated in the greenhouse ... selected from multigerm lines inoculated ... were more resistant than the ... group selected ... US 400 ... greenhouse ... were ... resistant than ... the possibility of increasing resistance through ... ests. Further experiments coupled with field ... more fully the possibilities ... black root ...

Pathogenicity of Aphanomyces cochlioides

... been continued to determine the ... of the fungus A. cochlioides. ... plated with isolates of the fungus from different ... osts. Although there are differences ... virulence ... isolates, ... e no variety-isolate interactions ... pathogen.

... occurrence of pathogenic ... could greatly affect the ... g black-root-resistant sugar beet varieties ... since the result ... investigations do not necessarily eliminate ... possi... ... their ... now ... in the future, studies are being continued on physiologic ... tion of the fungus.

SCREENING FOR BLACK ROOT RESISTANCE

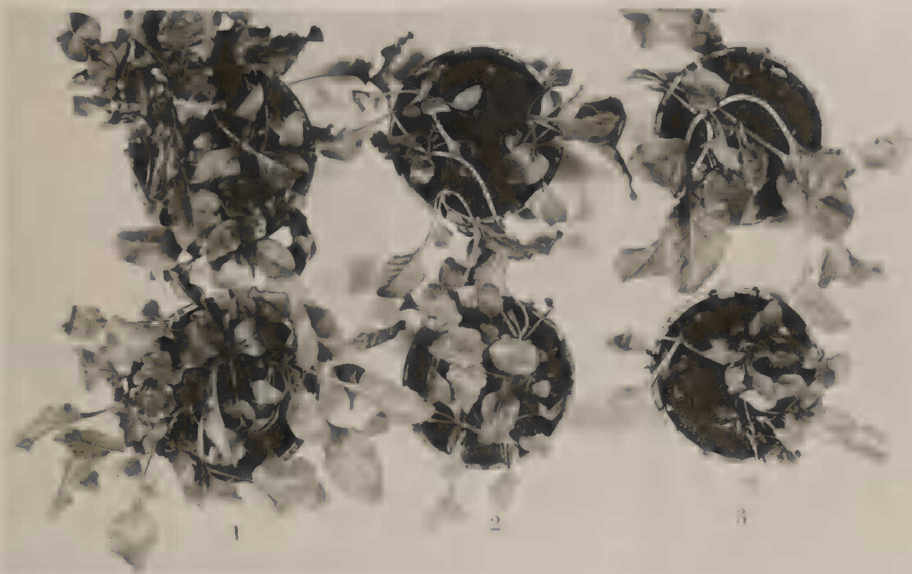

Figure 1. Greenhouse screening of monogerm progenies for resistance to Aphanomyces cochlioides.

Row 1. Monogerm Line 57746-01
Row 2. Monogerm Line 57763-01
Row 3. US 400

Figure 2. Resistance to Aphanomyces cochlioides found in Beta Introduction.

Row A, US 400; Row B, Susceptible Check;
Row C, P.I. 113306; Row D, P.I. 120693.

PART X

DEVELOPMENT AND EVALUATION OF SUGAR BEET VARIETIES SUITABLE FOR THE GREAT LAKES REGION

and

Breeding to Combine Resistance to Leaf Spot, Black Root, and Curly Top in High Quality Lines and Productive Varieties.

Foundation Project 26

Dewey Stewart
G. E. Coe
C. L. Schneider
J. O. Gaskill
F. V. Owen
A. M. Murphy
H. W. Bockstahler
G. J. Hogaboam
J. C. Overpeck

Cooperators conducting field tests:

- Farmers & Manufacturers Beet Sugar Association
- The Great Western Sugar Company
- American Crystal Sugar Company
- Holly Sugar Corporation
- Spreckels Sugar Company
- Colorado Agricultural Experiment Station
- Michigan Agricultural Experiment Station
- New Mexico Agricultural Experiment Station

Development and Evaluation of Varieties Suitable for the Great Lakes Region, and Breeding to Combine Resistance to Leaf Spot and Curly Top[1/]

The results presented in Part X of this Report pertain mostly to the performances of varieties and basic breeding material that have been developed in a program of varietal improvement for the Great Lakes region where leaf spot and black root are hazards in sugar beet production. The tests reported from this region are of special interest in appraising the effectiveness of the breeding program and will be treated separately from tests conducted in the irrigated districts.

In some sugar beet districts, where damage caused by curly top has been greatly reduced through the use of resistant varieties, leaf spot appears to be increasing. For potential use in these and in other districts where either leaf spot or curly top may occur in epidemic proportions, basic breeding material and varieties are being developed. Part VIII of the 1957 Report was devoted to evaluations of material developed in this program of breeding, but this year, fewer varieties are under test and they are included in Part X.

Cooperative Tests in the Great Lakes Region

Cooperative evaluation tests were conducted with US 401 and 5 other varieties in Michigan, Ohio, Minnesota, and Ontario, Canada. The results of 12 tests have been summarized in Tables 1, 2, and 3. Except in the test at Fremont, Ohio, where leaf spot was reported as moderate and black root as rather severe, and at Findlay, Ohio, where black root was reported as moderate, neither leaf spot nor black root was a factor in the performance of the varieties. Root rot was noted in tests at Fremont and Findlay, Ohio, and at Hollandale, Minnesota, and the damage was attributed to *Rhizoctonia solani*.

The highest average gross sugar was obtained with SP 5510-0 (Accession 1402). This synthetic variety was above US 401 in both yield of roots and sucrose percentage. On the basis of the performances of SP 5510-0 in the 12 tests of 1958 and in 13 tests of 1957 (1957 Report, pages 128, 129, 130), one concludes that SP 5510-0 is superior to US 401 in sucrose percentage and equal to it in root yield; however, SP 5510-0 is more likely to bolt.

The average sucrose percentage of the monogerm variety SP 566-0 that was included in the 12 cooperative tests was higher than the percentage of US 401, but the root yields and gross sugar production were about 15 percent lower. In Michigan tests, reported on pages 210, 212, and 214, the monogerm varieties SP 557-0 and SP 558-0 performed similarly to SP 566-0. Another monogerm synthetic variety, SP 5832-0, was evaluated in late-planted tests by M. R. Berrett in Michigan, The Great Western Sugar Company in Ohio, and J. O. Gaskill in Colorado. This monogerm synthetic variety is low in root yield when compared with US 400 and with US 401.

[1/] Discussion by Dewey Stewart

In tests of 1958, the sucrose percentage for SP 5481-0 (Accession 1401) was slightly higher than for US 401. This was also true for tests of 1957. Although the differences have not been great for the two years, the average sucrose percentage and gross sugar production have been greater for SP 5481-0 than for US 401, and the trend to replace US 401 with SP 5481-0 seems justified. Furthermore, SP 5481-0 is more resistant to leaf spot and black root.

Breeding to Develop Varieties Resistant to Curly Top and Leaf Spot

Progress has been made in breeding to combine resistance to leaf spot and curly top. A variety developed in this breeding program has been designated US 104. Work is being continued with selections made for curly top resistance at State College, New Mexico, and at Jerome, Idaho, and for leaf spot resistance at the Plant Industry Station.

Six varieties (SP 554-0, SP 555-0, SP 5551-0, SP 579-02, SP 57108-0, and SP 57109-0) developed in this breeding program were included in tests conducted in Michigan (pages 210, 212, 214), Colorado (pages 234,239), California (page 241), New Mexico (page 44), and Utah (page 79).

Attention is directed to SP 57109-0. In 3 tests in Michigan, where disease was not a factor in the growth of the plants, the average gross sugar yield per acre for SP 57109-0 was only 171 pounds lower than US 401. In each of the 3 tests, the sucrose percentage of SP 57109-0 was higher than US 401, with an average value of 0.4 percent in favor of SP 57109-0. These performances in sucrose percentage and sugar yield, without disease as a factor in growth of the plants, show distinct improvement of SP 57109-0 over the expected relative performances of US 104. In the test at State College, New Mexico, where both curly top and leaf spot occurred in epidemic proportions, SP 57109-0 was higher in root yield than US 22/4 or the other curly-top resistant varieties in the test. In a field test at Fort Collins (page 239) and at the Plant Industry Station, SP 57109-0 was approximately equal to US 401 in leaf spot resistance. In a test at Salt Lake City, SP 57109-0 gave excellent root yield under nematode and curly top exposure.

SP 57109-0 was derived from polycross progenies of US 104 grown under severe curly top exposure at Jerome, Idaho, in 1954. Selections from the polycross progenies were brought to seed by A. M. Murphy in 1955. These seedlots from Idaho were grown under leaf spot exposure at the Plant Industry Station in 1956, and selections were made by G. E. Coe. A group of selected plants were interpollinated to give SP 57109-0.

A new approach in breeding to combine resistance to leaf spot and curly top is under way, using US 201 as the source of leaf spot resistance. This program was mentioned on page 1 and in Part VIII of 1957 Report. Accomplishments in this program of breeding are reported herein on pages 243-249 by F. V. Owen and associates.

Cooperative Evaluation Tests
1958

Leaf Spot and Black Root Resistant Varieties of Sugar Beets

Seed No.	Description
1. SP 5714-0	An increase of a synthetic, SP 5614-0, obtained by interpollinating clones of plants producing polycross progenies that were outstanding in performances under severe leaf spot epidemic and moderate black root exposure on the Plant Industry Station. The leaf spot resistance of SP 5614-0 was excellent, and under severe disease exposure the variety was significantly above US 400 in sucrose percentage.
2. SP 5724-0	Produced on the Plant Industry Station by interplanting seven synthetic varieties: SP 5510-0 (see Item 3 below) SP 5512-0 (see Acc. 1379 of 1957 tests) SP 5614-0 (see Item 1 above); and SP 5616-0, SP 5644-0, SP 5646-0, and SP 55600-01 Except for SP 55600-01 all the synthetic varieties used as parents in SP 5724-0 were obtained by interpollinating clones or selfed progenies of superior mothers.
3. Acc. 1402	West Coast 7370, increase of SP 5510-0. This synthetic variety was included in tests of 1957 as Acc. 1378. It is of interest to include Acc. 1402 in tests of 1958.
4. Acc. 1401	West Coast 7328, increase of SP 5481-0, a variety that has shown some superiority over US 401. See Part VII, 1957 Report - Sugar Beet Research.
5. Acc. 1400	West Coast 7359 - US 401.
6. Acc. 1405 (Monogerm)	West Coast 7209, increase of SP 566-0. A pooling of ten monogerm progenies. This monogerm will have good leaf spot resistance, but root yield probably will not equal that of US 401. It was the best of the monogerm varieties available in the leaf spot and black root breeding project in 1956--the time when the proposals for seed increase were sent out to the Beet Sugar Development Foundation.

The performances of these varieties in tests conducted in the Great Lakes area have been summarized in Tables 1, 2, and 3. The tests conducted in irrigated districts have been included in this part of the report, but the results have not been summarized.

Summary Table 1.--Acre-yield of gross sugar in agronomic tests conducted in the Great Lakes area in 1958 to evaluate US 401 and related varieties of sugar beets developed for the humid region. Data are given as 6-plot averages, except as noted.

Data from page	Grower and Location	Field test conducted by	Acc. 1400 US 401	Acc. 1401 SP 5481-0	Acc. 1402 SP 5510-0	SP 5714-0	SP 5724-0	Acc. 1405 SP 566-0	LSD Odds 19:1
			Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
204	Gremel, H. Sebewaing, Mich.	Berrett Reeve	8665	8425	8295	7577	8626	6771	829
210	Rader, B. Saginaw, Mich.	Berrett Reeve	5589	5820	6162	5109	6110	5212	775 1/
206	Schultz, W. Bay City, Mich.	Berrett Reeve Nichol	7812	7086	7842	6225	6988	5233	1891
216	Mich. Exp. Sta. E. Lansing, Mich.	Bockstahler Hogaboam	5188	5869	5961	5186	5871	5899	689
212	Mich. Exp. Sta. E. Lansing, Mich.	Bockstahler Hogaboam	8487	8388	8745	7310	8730	7599	827 1/
218	M.S.U. Muck Sta. Bath, Mich.	Shepherd	6854	7106	6891	6303	6608	6802	492
208	Kleman, B. Ottawa, Ohio	Berrett Reeve	4710	4993	5462	4913	5164	3720	750
224	Haas, G. Fremont, Ohio	Brewbaker Bush Sunderland	6775	6747	7287	5841	7039	5332	614
226	Krauss, E. S. Findlay, Ohio	Brewbaker Bush Sunderland	4588	4753	4957	4278	4110	4477	529
233 2/	Ravenhorst, H. Hollandale, Minn.	Farus	5560	5477	6015	5312	5899	4944	469
220	C. & D. Sugar Co. Wallaceburg, Ont.	Broadwell	5575	5201	5659	4935	5511	4060	654
222	Vanneste, J. Clandeboye, Ont.	Broadwell	6082	5691	5719	5667	5818	5221	499
Mean of 12 tests in humid region			6324	6296	6583	5721	6373	5439	
US 401 as 100%			100.0	99.6	104.1	90.5	100.8	86.0	

1/ More than 6 varieties occurred in the test. 2/ Results given as 8-plot averages.

Summary Table 2.--Acre-yield of roots in agronomic tests conducted in the Great Lakes area in 1958 to evaluate US 401 and related varieties of sugar beets developed for the humid region. Data are given as 6-plot averages, except as noted.

Data from page	Grower and Location	Field test conducted by	Acc. 1400 US 401	Acc. 1401 SP 5481-0	Acc. 1402 SP 5510-0	SP 5714-0	SP 5724-0	Acc. 1405 SP 566-0	LSD Odds 19:1
			Tons	Tons	Tons	Tons	Tons	Tons	Tons
204	Gremel, H. Sebewaing, Mich.	Berrett Reeve	25.18	23.10	22.90	21.05	23.96	19.46	2.24
210	Rader, E. Saginaw, Mich.	Berrett Reeve	15.67	16.31	16.90	14.41	17.04	14.58	1.52 1/
206	Schultz, W. Bay City, Mich.	Berrett Reeve Nichol	25.63	21.59	24.62	19.97	21.75	17.38	5.48
216	Mich. Exp. Sta. E. Lansing, Mich.	Bockstahler Hogaboam	18.69	20.37	20.84	17.26	19.93	19.85	1.83
212	Mich. Exp. Sta. E. Lansing, Mich.	Bockstahler Hogaboam	26.81	26.09	26.89	22.94	27.00	23.14	2.15 1/
218	M.S.U. Muck Sta. Bath, Mich.	Shepherd	24.00	24.00	23.40	21.40	22.00	22.00	1.38
208	Kleman, E. Ottawa, Ohio	Berrett Reeve	13.92	14.46	15.50	14.15	14.76	10.67	1.83
224	Haas, G. Fremont, Ohio	Brewbaker Bush Sunderland	23.64	22.84	25.04	20.14	23.91	18.11	2.09
226	Krauss, E. Findlay, Ohio	Brewbaker Bush Sunderland	17.81	18.58	19.02	16.29	16.22	17.46	1.96
233 2/	Ravenhorst, H. Hollandale, Minn.	Farus	22.03	21.81	23.72	20.29	23.19	18.53	1.72
220	C. & D. Sugar Co. Wallaceburg, Ont.	Broadwell	17.73	16.23	17.75	15.36	17.41	13.22	0.49
222	Vanneste, J. Clandeboye, Ont.	Broadwell	18.40	17.22	17.33	17.11	17.55	15.71	1.53
Mean of 12 tests in humid region			20.79	20.22	21.16	18.36	20.39	17.51	
US 401 as 100%			100.0	97.3	101.8	88.3	98.1	84.2	

1/ More than 6 varieties occurred in the test. 2/ Results given as 8-plot averages.

Summary Table 3.--Sucrose percentages in agronomic tests conducted in the Great Lakes area in 1958 to evaluate US 401 and related varieties of sugar beets developed for the humid region. Results are given as 6-plot averages, except as noted.

Data from page	Grower and Location	Field test conducted by	Acc. 1400 US 401	Acc. 1401 SP 5481-0	Acc. 1402 SP 5510-0	SP 5714-0	SP 5724-0	Acc. 1405 SP 566-0	LSD Odds 19:1
			%	%	%	%	%	%	%
204	Gremel, H. Sebewaing, Mich.	Berrett Reeve	17.20	18.20	18.08	17.98	18.00	17.35	0.60
210	Rader, B. Saginaw, Mich.	Berrett Reeve	17.90	17.90	18.30	17.80	18.00	17.90	0.57[1/]
206	Schultz, W. Bay City, Mich.	Berrett Reeve Nichol	15.32	16.37	15.87	15.58	16.10	14.98	N.S.
216	Mich. Exp. Sta. E. Lansing, Mich.	Bockstahler Hogaboam	13.80	14.37	14.18	14.83	14.65	14.82	N.S.
212	Mich. Exp. Sta. E. Lansing, Mich.	Bockstahler Hogaboam	15.80	16.10	16.30	16.00	16.20	16.40	0.65[1/]
218	M.S.U. Muck Sta. Bath, Mich.	Shepherd	14.80	15.00	15.00	15.00	15.30	15.70	0.59
208	Kleman, E. Ottawa, Ont.	Berrett Reeve	16.87	17.30	17.70	17.40	17.48	17.38	N.S.
224	Haas, G. Fremont, Ohio	Brewbaker Bush Sunderland	14.33	14.77	14.55	14.50	14.72	14.72	0.47
226	Krauss, B. Findlay, Ohio	Brewbaker Bush Sunderland	12.88	12.79	13.03	13.13	12.67	12.82	0.55
233[2/]	Ravenhorst, H. Hollandale, Minn.	Farus	12.62	12.54	12.68	13.09	12.72	13.34	0.35
220	C. & D. Sugar Co. Wallaceburg, Ont.	Broadwell	15.68	16.02	15.95	16.00	15.82	15.30	N.S.
222	Vanneste, J. Clandeboye, Ont.	Broadwell	16.55	16.53	16.48	16.57	16.57	16.60	N.S.
Mean of 12 tests in humid region			15.31	15.66	15.68	15.66	15.69	15.61	
US 401 as 100%			100.0	102.3	102.4	102.3	102.5	102.0	

1/ More than 6 varieties occurred in the test. 2/ Results given as 8-plot averages.

AGRONOMIC EVALUATION TEST - 1958

Conducted by: M. R. Berrett, P. A. Reeve.

Location: Harold Gremel farm, Sebewaing, Michigan.

Cooperation: F & M Beet Sugar Association.

Date of Planting: April 2.

Date of Harvest: October 31.

Experimental Design: 6 x 6 Latin Square.

Size of plots: 4 rows x 70 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 2 center rows x 68 feet, hand topped.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1957 - Beans, 300# 5-20-20; 1956 - Hay and Pasture, No fertilizer; 1955 - Sugar Beets and Oats, 250# 5-20-20; 1954 - 900# 5-20-20 - beside and under seed, 200# 10-10-10 - with seed.

Fertilization of Beet Crop: 600# 6-24-12 with Boron and Manganese to the side and under seed, 150# 10-10-10 with Boron and Manganese with the seed.

Leafspot Exposure: Slight.

Black Root Exposure: None.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Moist seedbed, seasonal moisture adequate.

Reliability of Test: Excellent.

Cooperator: F & M Beet Sugar Association. Year: 1958

Location: Harold Gremel farm, Sebewaing, Michigan. Expt.: 1

(Results given as 6 plot averages)

Variety and Description			Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
			Pounds	Tons	Percent	Number
SP 5714-0	Incr. of 5614-0 Syn.		7577	21.05	17.98	89
SP 5724-0	Incr. of 7 Syn. Vars.		8626	23.96	18.00	89
Acc 1402	WC 7370	5510-0 Syn.	8295	22.90	18.08	84
Acc 1401	WC 7328	5481-0	8425	23.10	18.20	87
Acc 1400	WC 7359	US 401	8665	25.18	17.20	86
Acc 1405	WC 7209	566-0 Mono	6771	19.46	17.35	82
General Mean			8110	22.62	17.81	86
S. E. Variety Mean			207	0.56	0.15	2
" " " as % of Gen. Mean			2.55	2.48	0.84	2.33
Diff. req. for sig. (Odds 19:1)			829	2.24	0.60	N.S.

Variance Table

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between columns	5	1,877,626	11.6891	0.6076	108
Between rows	5	3,767,496	21.4624	0.9396	25
Between varieties	5	3,322,795	25.3150	1.0516	41
Remainder-Error	20	257,511	1.8824	0.1358	30
Total	35				
Calculated F. value		12.90**	13.45**	7.74**	1.37
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% level		4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1958

Conducted by: M. R. Barrett, P. A. Reeve, G. E. Nichol.

Location: Walter Schultz farm, Bay City, Michigan.

Cooperation: F & M Beet Sugar Association, Monitor Sugar Division.

Date of Planting: April 5.

Date of Harvest: October 14.

Experimental Design: 6 x 6 Latin Square.

Size of plots: 4 rows x 70 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 2 center rows x 68 feet, hand topped.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1957 - Wheat seeded to alfalfa, 500# 4-16-16; 1956 - Potatoes, 1000# 4-16-16; 1955 - Beets, 800# 4-16-16.

Fertilization of Beet Crop: 700# 6-12-12 broadcast; 800# 4-11-11 banded at planting time.

Leafspot Exposure: None.

Black Root Exposure: None.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Dry seedbed. Seasonal moisture adequate.

Reliability of Test: Excellent.

Cooperator: F & M Beet Sugar Association and Monitor Sugar Division. Year: 1958

Location: Walter Schultz farm, Bay City, Michigan. Expt.: 2

(Results given as 6 plot averages)

Variety and Description	Acre-Yield: Gross Sugar	Acre-Yield: Roots	Sucrose	Beets per 100' of row
	Pounds	Tons	Percent	Number
SP 5714-0 Incr. of 5614-0 Syn.	6225	19.97	15.58	89
SP 5724-0 Incr. of 7 Syn. Vars.	6988	21.75	16.10	96
Acc 1402 WC 7370 5510-0 Syn.	7842	24.62	15.87	102
Acc 1401 WC 7328 5481-0	7086	21.59	16.37	104
Acc 1400 WC 7359 US 401	7812	25.63	15.32	105
Acc 1405 WC 7209 566-0 Mono	5233	17.38	14.98	91
General Mean	6866	21.83	15.71	98
S. E. Variety Mean	473	1.37	0.32	4
" " " as % of Gen. Mean	6.89	6.58	2.04	4.08
Diff. req. for sig. (Odds 19:1)	1,891	5.48	N.S.	N.S.

Variance Table

Source of variation	D/F	Mean Squares: Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between columns	5	779,695	10.2948	0.3410	86
Between rows	5	2,126,908	18.0377	0.9303	137
Between varieties	5	5,985,611	54.6228	1.5676	283
Remainder-Error	20	1,339,879	11.2386	0.6008	111
Total Calculated F. value	35	4.47**	4.86**	2.61	2.55
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% "		4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1958

Conducted by: M. R. Berrett, P. A. Reeve.

Location: Elizabeth Kleman farm, Ottawa, Ohio.

Cooperation: F & M Beet Sugar Association, Buckeye Sugars Inc.

Date of Planting: May 14.

Date of Harvest: October 29.

Experimental Design: 6 x 6 Latin Square.

Size of plots: 4 rows x 70 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 2 center rows x 68 feet, hand harvested.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1957 - Alfalfa-Timothy Hay; 1956 - Alfalfa-Timothy Hay; 1955 - Oats seeded, 200# 3-12-12; 1954 - Corn, 200# 3-12-12.

Fertilization of Beet Crop: 350# 5-20-20 plowed down, 200# 5-10-10 in the row.

Leafspot Exposure: Slight.

Black Root Exposure: Slight.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Dry seedbed, spotty water damage from June and July rains.

Reliability of Test: Fair.

Cooperator: F & M Beet Sugar Association and Buckeye Sugars, Inc. Year: 1958

Location: Elizabeth Kleman farm, Ottawa, Ohio. Expt.: 3

(Results given as 6 plot averages)

Variety and Description	Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
	Pounds	Tons	Percent	Number
SP 5714-0 Incr. of 5614-0 Syn.	4913	14.15	17.40	75
SP 5724-0 Incr. of 7 Syn. Vars.	5164	14.76	17.48	72
Acc 1402 WC 7370 5510-0 Syn.	5462	15.50	17.70	76
Acc 1401 WC 7328 5481-0	4993	14.46	17.30	72
Acc 1400 WC 7359 US 401	4710	13.92	16.87	69
Acc 1405 WC 7209 566-0 Mono	3720	10.67	17.38	62
General Mean	4828	13.91	17.36	71
S. E. Variety Mean	187	0.46	0.27	4
" " " as 1% of Gen. Mean	3.87	3.31	1.56	5.63
Diff. req. for sig. (Odds 19:1)	750	1.83	N.S.	N.S.

Variance Table

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between columns	5	182,838	2.3670	0.4124	25
Between rows	5	7,774,414	66.0874	0.0991	667
Between varieties	5	2,150,420	16.9032	0.4558	164
Remainder-Error	20	210,694	1.2580	0.4446	79
Total	35				
Calculated F. value		10.21**	13.44**	1.03	2.08
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% "		4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1958

Conducted by: M. R. Berrett, P. A. Reeve.

Location: Elmer Rader farm, Saginaw, Michigan.

Cooperation: F & M Beet Sugar Association.

Date of Planting: May 3.

Date of Harvest: October 11.

Experimental Design: 5 x 5 Triple lattice. Six replications.

Size of plots: 8 rows x 20 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 6 inner rows x 18 feet, hand topped.

Samples for Sucrose Determinations: One ten-beet sample of consecutive beets from each of the outside harvested rows.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1957 - Wheat; 1956 - Beets seeded, abandoned, 500# 5-20-20; 1955 - Alfalfa plowed down - fallow; 1954 - Oats seeded 300# 5-20-20.

Fertilization of Beet Crop: 500# 6-24-12.

Leafspot Exposure: None.

Black Root Exposure: Slight.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Moist seedbed, seasonal moisture adequate.

Reliability of Test: Good.

Cooperator: F & M beet Sugar Association. Year: 1958

Location: Elmer Rader farm, Saginaw, Michigan. Expt.: 2501

(Results given as 6 plot averages)

Variety and Description	Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
	Pounds	Tons	Percent	Number
Acc 1400 WC 7359 US 401 MM	5589	15.67	17.9	92
Acc 1401 WC 7328 5481-0 MM	5820	16.31	17.9	101
Acc 1402 WC 7370 5510-0 MM	6162	16.90	18.3	97
Acc 1411 WC 7337 5611-0 MM	6027	16.55	18.2	94
Acc 1412 WC 7320 5512-0 MM	5781	15.89	18.2	94
SP 5713-0 Syn. Var. MM	4907	13.53	18.2	96
SP 5714-0 Syn. Var. MM	5109	14.41	17.8	96
SP 5716-0 Syn. Var. MM	5717	16.41	17.4	93
SP 5724-0 Syn. Var. MM	6110	17.04	18.0	99
SP 573565-01 Syn. Var. MM	5652	15.90	17.8	93
SP 573566-01 Syn. Var. MM	5929	16.88	17.6	98
Acc 1409 WC 7324 55600-01 MM	5924	16.13	18.4	96
Acc 1410 WC 6327 5460-0 MM	5375	14.55	18.4	92
Acc 1416 U-I 554-0 MM	5200	14.39	18.1	88
Acc 1417 U-I 555-0 MM	5162	14.82	17.5	90
Acc 1418 U-I 5551-0 MM	5811	16.16	18.0	90
SP 57108-0 Syn. Var. MM	5708	15.88	18.0	91
SP 57109-0 Syn. Var. MM	5532	15.17	18.2	87
Acc 1403 WC 7207 557-0 mm	5162	14.19	18.2	94
Acc 1404 WC 7208 558-0 mm	5070	13.82	18.3	92
Acc 1405 WC 7209 566-0 mm	5212	14.58	17.9	93
Acc 1398 ACS(610x91) 91x5460-0 mm	5668	15.63	18.2	96
Acc 1420 WC 7316 SL108ms x 5460-0 mm	5637	15.34	18.4	95
Acc 1396 5515-01ms x 5460-0 & US 401 mm	5961	16.31	18.3	101
Acc 2056 WC 4441 US 400 MM	5862	16.47	17.8	93
General Mean	5603	15.56	18.02	94
S. E. Variety Mean	277	.54	.21	2.5
" " " as % of Gen. Mean	4.94	3.47	1.17	2.66
Diff. req. for sig. (Odds 19:1)	775	1.52	.57	8

Variance Table

Random Block Analysis

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between replications	5	2,384,311	24.6552	4.216	205.4
Between varieties	24	770,780	6.2231	0.504	77.3
Remainder-Error	120	459,963	1.7760	0.263	47.1
Total	149				
Calculated F. value		1.68*	3.50**	1.92*	1.64*
Req. for sig. 5% level	24/120	1.61	1.61	1.61	1.61
" " " 1% "		1.95	1.95	1.95	1.95

AGRONOMIC EVALUATION TEST- 1958

Conducted by: H. W. Bockstahler, G. J. Hogaboam.

Location : M. S. U. farm, East Lansing, Michigan.

Cooperation : Mich. Agr. Expt. Station- Farm Crops Department.

Date of Planting : April 25.

Date of Harvest : October 28-30.

Experimental Design : 5 x 5 Triple Lattice, 6 replications.

Size of Plots : 5 rows x 44 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield : 3 inner rows x 42 feet, hand topped.

Samples for Sucrose Determination : One 10-beet sample of consecutive beets from each of the outside harvested rows.

Stand Counts : Harvested beets counted when weighed.

Recent Field History : 1957- Red Clover. 1000# 5-20-20 plowed down. Field-cultivated 10"-12" deep in fall. 1956- Sugar beets, broadcast seeding.

Fertilization of Beet Crop: 1000# 5-20-20 plowed down.

Leaf Spot Exposure : Slight.

Black Root Exposure: Slight.

Other Diseases and Pests : Heavy infestation of Mosaic.

Soil and Seasonal Conditions : Moist seedbed but no rain until May 31. Ample moisture remainder of season. Emergence irregular, showed varietal or planter differences (4 Planet Jr. seeders used).

Reliability of Test : More of an evaluation of emergence capability of the varieties under early drought conditions. Laboratory tests for emergence showed good confirmation of the initial emergence of the varieties in the field. Harvest yields bore out these observations.

Cooperator: Michigan Agricultural Experimental Station, Farm Crops Department. Year: 1958

Location: East Lansing, Michigan. Expt.: 2512

(Results given as 6 plot averages)

Variety and Description	Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
	Pounds	Tons	Percent	Number
Acc 1400 WC 7359 US 401 MM	8487	26.81	15.8	80
Acc 1401 WC 7328 5481-0 MM	8388	26.09	16.1	85
Acc 1402 WC 7370 5510-0 MM	8745	26.89	16.3	80
Acc 1411 WC 7337 5611-0 MM	6928	21.43	16.2	63
Acc 1412 WC 7320 5512-0 MM	6685	21.06	15.9	69
SP 5713-0 Syn. Var. MM	7336	22.34	16.4	76
SP 5714-0 Syn. Var. MM	7310	22.94	16.0	74
SP 5716-0 Syn. Var. MM	8212	26.13	15.7	77
SP 5724-0 Syn. Var. MM	8730	27.00	16.2	84
SP 573565-01 Syn. Var. MM	8805	27.37	16.1	84
SP 573566-01 Syn. Var. MM	7238	22.92	15.8	66
Acc 1409 WC 7324 55600-01 MM	8486	26.13	16.3	85
Acc 1410 WC 6327 5460-0 MM	7650	24.06	15.9	66
Acc 1416 U-I 554-0 MM	6535	21.41	15.2	61
Acc 1417 U-I 555-0 MM	5470	17.31	15.8	60
Acc 1418 U-I 5551-0 MM	7429	23.34	15.9	74
SP 57108-0 Syn. Var. MM	6386	20.62	15.3	60
SP 57109-0 Syn. Var. MM	7926	24.56	16.1	78
Acc 1403 WC 7207 557-0 mm	7259	22.11	16.4	84
Acc 1404 WC 7208 558-0 mm	6931	21.40	16.2	82
Acc 1405 WC 7209 566-0 mm	7599	23.14	16.4	79
Acc 1398 ACS(610x91) 91x5460-0 mm	8360	25.80	16.2	81
Acc 1420 WC 7316 SL108ms x 5460-0 mm	6623	21.04	15.7	66
Acc 1396 5515-01ms x 5460-0 & US 401 mm	8356	25.46	16.4	81
Acc 2056 WC 4441 US 400 MM	7097	22.52	15.6	71
General Mean	7559	23.59	15.98	75
S. E. Variety Mean	295	.77	.23	3.1
" " " as % of Gen. Mean	3.90	3.26	1.44	4.13
Diff. req. for sig. (Odds 19:1)	827	2.15	.65	9

Variance Table

Random Block Analysis

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between replications	5	9,000,952	54.6862	5.700	186.6
Between varieties	24	4,563,696	39.3281	.632	434.2
Remainder-Error	120	523,840	3.5354	.338	58.7
Total	149				
Calculated F. value		8.75**	11.12**	1.87*	7.40**
Req. for sig. 5% level	24/120	1.61	1.61	1.61	1.61
" " " 1% "		1.95	1.95	1.95	1.95

BLACK ROOT NURSERY TEST- 1958

Conducted by: H. W. Bockstahler, G. J. Hogaboam.

Location : M. S. U. farm, East Lansing, Michigan.

Cooperation : Mich. Agr. Expt. Station- Farm Crops Department.

Date of Planting: May 6.

Date of Harvest : October 23-24.

Experimental Design : 5 x 5 Triple Lattice, 6 replications.

Size of Plots : 1 row x 22 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield : 1 row x 20 feet.

Samples for Sucrose Determination : All beets in row taken for one sugar sample.

Stand Counts: Harvested beets counted when weighed.

Recent Field History : 1957- Beets (nursery plots) 1000# 5-20-20 plowed down. 1956- Beets, broadcast seeding. 1955- Beets, broadcast seeding.

Fertilization of Beet Crop: 1000# 5-20-20 plowed down.

Leaf Spot Exposure: Moderate.

Black Root Exposure: Moderate.

Other Diseases and Pests: Heavy infestation of Mosaic. One plant showed symptoms of Curly Top.

Soil and Seasonal Conditions : Seedbed medium dry. Irrigated May 19 & 29, one inch each. Rain May 31- 1 3/4 inches. Ample moisture remainder of season.

Reliability of Test : Good. Emergence differences not obvious.

Cooperator: Michigan Agricultural Experimental Station, Farm Crops Department. Year: 1958

Location: East Lansing, Michigan. Expt.: 2511

(Results given as 6 plot averages)

Variety and Description	Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
	Pounds	Tons	Percent	Number
Acc 1400 WC 7359 US 401 MM	6017	19.68	15.3	90
Acc 1401 WC 7328 5481-0 MM	6042	18.52	16.4	88
Acc 1402 WC 7370 5510-0 MM	5500	16.96	16.3	93
Acc 1411 WC 7337 5611-0 MM	5566	17.51	15.9	86
Acc 1412 WC 7320 5512-0 MM	5079	16.18	15.7	77
SP 5713-0 Syn. Var. MM	4968	15.87	15.7	87
SP 5714-0 Syn. Var. MM	4497	13.93	16.2	85
SP 5716-0 Syn. Var. MM	5517	17.74	15.5	87
SP 5724-0 Syn. Var. MM	6300	19.61	16.1	93
SP 573565-01 Syn. Var. MM	6705	20.54	16.3	98
SP 573566-01 Syn. Var. MM	6065	18.83	16.2	92
Acc 1409 WC 7324 55600-01 MM	5677	17.82	15.9	94
Acc 1410 WC 6327 5460-0 MM	5401	16.88	15.9	83
Acc 1416 U-I 554-0 MM	5212	16.18	16.2	92
Acc 1417 U-I 555-0 MM	5261	16.26	16.2	81
Acc 1418 U-I 5551-0 MM	5636	17.66	16.1	80
SP 57108-0 Syn. Var. MM	5157	15.79	16.5	86
SP 57109-0 Syn. Var. MM	6124	19.21	15.9	93
Acc 1403 WC 7207 557-0 mm	4677	15.02	15.6	95
Acc 1404 WC 7208 558-0 mm	4583	14.16	16.1	93
Acc 1405 WC 7209 566-0 mm	5696	17.04	16.8	99
Acc 1398 ACS(610x91) 91x5460-0 mm	6621	20.30	16.2	101
Acc 1420 WC 7316 SL108ms x 5460-0 mm	6197	18.59	16.6	100
Acc 1396 5515-01ms x 5460-0 & US 401 mm	6363	19.76	16.1	98
Acc 2056 WC 4441 US 400 MM	6262	20.62	15.2	91
General Mean	5645	17.62	16.02	90
S. E. Variety Mean	360	1.11	.31	4.6
" " " as % of Gen. Mean	6.38	6.30	1.94	5.11
Diff. req. for sig. (Odds 19:1)	1002	3.11	.86	13

Variance Table

Random Block Analysis

Source of variation	D/F	Mean Squares Gross Sugar	Mean Squares Roots	Mean Squares Sucrose	Mean Squares Beets per 100' of row
Between replications	5	4,137,753	20.6922	12.640	250.8
Between varieties	24	2,312,570	22.3519	0.888	249.5
Remainder-Error	120	776,557	7.3018	0.587	123.2
Total					
Calculated F. value	149	2.98**	3.06**	1.51 NS	2.02**
Req. for sig. 5% level	24/120	1.61	1.61	1.61	1.61
" " " 1% "		1.95	1.95	1.95	1.95

AGRONOMIC EVALUATION TEST

Conducted by: H. W. Bockstahler, G. J. Hogaboam.

Location: Michigan State University farm, East Lansing, Michigan.

Cooperation: Michigan Agricultural Experimental Station, Farm Crops Dept. ~~Department.~~

Date of Planting: April 25.

Date of Harvest: October 27.

Experimental Design: 6 x 6 Latin Square.

Size of plots: 5 rows x 44 feet, 28 inches between rows.

Harvested Area per Plot for Root Yield: 3 rows x 42 feet.

Samples for Sucrose Determinations: One ten-beet sample of consecutive beets from each outside harvested row.

Stand Counts: Harvested beets counted when weighed.

Recent Field History: 1957 - Red Clover, 1000# 5-20-20 plowed down. Field cultivated 10"-12" deep in fall. 1956 - Sugar beets (broadcast seeding). 1955 - Beets (broadcast seeding).

Fertilization of Beet Crop: 1000# 5-20-20 plowed down.

Leafspot Exposure: Slight.

Black Root Exposure: Slight.

Other Diseases and Pests: Heavy infestation of Mosaic.

Soil and Seasonal Conditions: Moist seedbed, no rain until May 31, ample moisture remainder of season. Emergence irregular, showed varietal or planter differences (4 Planet Jr. seeders used).

Reliability of Test: More of an evaluation of emergence capability of the varieties under early drought conditions. Laboratory tests for emergence showed good confirmation of the initial emergence of the varieties in the field. Harvest yields bore out these observations.

Cooperator: Michigan Agricultural Experimental Station, Farm Crops Department. Year: 1958

Location: East Lansing, Michigan. Expt.: 5

(Results given as 6 plot averages)

Variety and Description			Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
			Pounds	Tons	Percent	Number
SP 5714-0	Incr. of 5614-0 Syn.		5186	17.26	14.83	74
SP 5724-0	Incr. of 7 Syn. Vars.		5871	19.93	14.65	64
Acc 1402	WC 7370	5510-0 Syn.	5961	20.84	14.18	66
Acc 1401	WC 7328	5481-0	5869	20.37	14.37	70
Acc 1400	WC 7359	US 401	5188	18.69	13.80	70
Acc 1405	WC 7209	566-0 Mono	5899	19.85	14.82	70
General Mean			5663	19.50	14.44	69
S. E. Variety Mean			172	0.46	0.26	3
" " " as 1% of Gen. Mean			3.04	2.36	1.80	4.35
Diff. req. for sig. (Odds 19:1)			689	1.83	N.S.	N.S.

Variance Table

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between columns	5	4,873,820	25.8211	4.1178	200
Between rows	5	1,651,021	11.2110	0.7532	44
Between varieties	5	819,959	10.2387	0.9858	63
Remainder-Error	20	177,703	1.2553	0.4182	59
Total	35				
Calculated F. value		4.61 **	8.16 **	2.36	1.07
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% "		4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1958

Conducted by: L. N. Shepherd.

Location: Michigan State University Muck Experimental farm, Bath, Michigan.

Cooperation: Michigan Agricultural Experimental Station, Soils Department.

Date of Planting: April 29.

Date of Harvest: November 5.

Experimental Design: 6 x 6 Latin Square.

Size of plots: 8 rows x 22 feet, 33 inches between rows.

Harvested Area per Plot for Root Yield: 6 rows x 14 feet.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Uniform, full stand.

Recent Field History: 1957 and 1956 - Corn; 1955 and 1954 - Peppermint.

Fertilization of Beet Crop: 1000# 5-10-40.

Leafspot Exposure: None

Black Root Exposure: Slight.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Houghton Muck 80% organic. pH 6.2. Ample moisture.

Reliability of Test: Excellent.

Cooperator: Michigan Agricultural Experimental Station, Soils Department. Year: 1958

Location: Michigan State University Muck Experimental farm, Bath, Michigan. Expt. 7

(Results given as 6 plot averages)

Variety and Description			Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose
			Pounds	Tons	Percent
SP 5714-0	Incr. of 5614-0 Syn.		6303	21.4	15.0
SP 5724-0	Incr. of 7 Syn. Vars.		6608	22.0	15.3
Acc 1402	WC 7370	5510-0 Syn.	6891	23.4	15.0
Acc 1401	WC 7328	5481-0	7106	24.0	15.0
Acc 1400	WC 7359	US 401	6854	24.0	14.8
Acc 1405	WC 7209	566-0 Mono	6802	22.0	15.7
General Mean			6761	22.80	15.15
S. E. Variety Mean			123	0.34	0.15
" " " as % of Gen. Mean			1.82	1.49	0.99
Diff. req. for sig. (odds 19:1)			492	1.38	.59

Variance Table

Source of variation	D/F	Mean Squares Gross Sugar	Mean Squares Roots	Mean Squares Sucrose
Between columns	5	458,022	.61	1.11
Between rows	5	128,635	.71	.11
Between varieties	5	455,107	7.78	.60
Remainder-Error	20	90,851	.71	.13
Total	35			
Calculated F. value		5.01**	10.96**	4.62**
Req. for sig. 5% level	5/20	2.71	2.71	2.71
" " " 1% "		4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1958

Conducted by: C. E. Broadwell.

Location: C & D Sugar Company, Ltd. experimental farm, Wallaceburg, Ontario, Canada.

Cooperation: C & D Sugar Company, Ltd., F & M Beet Sugar Association.

Date of Planting: April 24 and 25.

Date of Harvest: September 30 to October 3.

Experimental Design: 6 x 6 Latin Square.

Size of plots: 4 rows x 70 feet, 24 inches between rows.

Harvested Area per Plot for Root Yield: 4 rows x 70 feet.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Beets counted at harvest.

Recent Field History: Corn, 500# 5-10-13; Tomatoes, 800# 5-10-13; Sugar Beets, 500# 2-12-20.

Fertilization of Beet Crop: 800# 0-20-20 broadcast in spring, 200# Amm. nitrate before planting.

Leafspot Exposure: Slight.

Black Root Exposure: None.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Seedbed fairly dry.

Reliability of Test: Very good.

Cooperator: C & D Sugar Company, Ltd., and F & M Beet Sugar Association. Year: 1958

Location: C & D Experimental farm, Wallaceburg, Ontario. Expt.: 6

(Results given as 6 plot averages)

Variety and Description	Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
	Pounds	Tons	Percent	Number
SP 5714-0 Incr. of 5614-0 Syn.	4935	16.36	16.00	85
SP 5724-0 Incr. of 7 Syn. Vars.	5511	17.41	15.82	86
Acc 1402 WC 7370 5510-0 Syn.	5659	17.75	15.95	89
Acc 1401 WC 7328 5481-0	5201	16.23	16.02	80
Acc 1400 WC 7359 US 401	5575	17.73	15.68	85
Acc 1405 WC 7209 566-0 Mono	4060	13.22	15.30	85
General Mean	5158	16.28	15.80	85
S. E. Variety Mean	163	0.12	0.26	3
" " " as % of Gen. Mean	3.16	0.75	1.65	3.53
Diff. req. for sig. (Odds 19:1)	654	0.49	N.S.	N.S.

Variance Table

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between columns	5	475,830	4.0813	0.0658	43
Between rows	5	2,038,699	15.9461	0.6631	214
Between varieties	5	2,167,162	18.8949	0.4478	54
Remainder-Error	20	160,331	.9000	0.4038	45
Total					
Calculated F. value	35	13.52 **	20.99 **	1.11	1.20
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% "		4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST - 1958

Conducted by: C. E. Broadwell.

Location: Joseph Vanneste farm, Clandeboye, Ontario, Canada.

Cooperation: C & D Sugar Company, Ltd., F & M Beet Sugar Association.

Date of Planting: May 21.

Date of Harvest: October 9.

Experimental Design: 6 x 6 Latin Square.

Size of plots: 4 rows x 70 feet, 24 inches between-rows.

Harvested Area per Plot for Root Yield: 4 rows x 70 feet.

Samples for Sucrose Determinations: Two ten-beet samples selected at random.

Stand Counts: Beets counted at harvest.

Recent Field History: 1957 and 1956 - Soy beans, 200# 4-24-20.

Fertilization of Beet Crop: 300# 10-10-10 plowed down in fall, 300# 4-24-20 broadcast in spring.

Leafspot Exposure: None.

Black Root Exposure: None.

Other Diseases and Pests: None.

Soil and Seasonal Conditions: Dry when planted but rain soon after.

Reliability of Test: Very good.

Cooperator: C & D Sugar Company, Ltd., and F & M Beet Sugar Association. Year: 1958

Location: Joseph Vanneste farm, Clandeboye, Ontario. Expt.: 4

(Results given as 6 plot averages)

Variety and Description			Acre-Yield Gross Sugar	Acre-Yield Roots	Sucrose	Beets per 100' of row
			Pounds	Tons	Percent	Number
SP 5714-0	Incr. of 5814-0 Syn.		5667	17.11	16.57	72
SP 5724-0	Incr. of 7 Syn. Vars.		5818	17.55	16.57	69
Acc 1402	WC 7370	5510-0 Syn.	5719	17.33	16.48	70
Acc 1401	WC 7328	5481-0	5691	17.22	16.53	72
Acc 1400	WC 7359	US 401	6088	18.40	16.55	70
Acc 1405	WC 7209	566-0 Mono	5221	15.71	16.60	76
General Mean			5701	17.22	16.55	72
S. E. Variety Mean			125	0.38	0.12	1
" " " as 1% of Gen. Mean			2.19	2.21	0.73	1.39
Diff. req. for sig. (Odds 19:1)			499	1.53	N.S.	5.42

Variance Table

Source of variation	D/F	Mean Squares Gross Sugar	Roots	Sucrose	Beets per 100' of row
Between columns	5	767,872	7.0419	0.0800	18
Between rows	5	561,696	3.4219	0.04813	18
Between varieties	5	468,522	4.5721	0.0093	32
Remainder-Error	20	93,295	0.8746	0.0798	11
Total	35				
Calculated F. value		5.02**	5.23**	N.S.	2.91*
Req. for sig. 5% level	5/20	2.71	2.71	2.71	2.71
" " " 1% "		4.10	4.10	4.10	4.10

AGRONOMIC EVALUATION TEST, 1958

Conducted by: H. E. Brewbaker, H. L. Bush and D. Sunderland

Location: Glenn Haas Farm, Fremont, Ohio

Cooperation: Northern Ohio Sugar Co.

Date of Planting: April 3, 1958

Date of Harvest: September 21, 1958

Experimental Design: Triple Rectangular Lattice

Size of Plots: 6 rows x 22 feet planted (32 inch rows)

Harvested Area per Plot for Root Yield: 6 rows x 18 feet

Samples for Sucrose Determination: 2 samples per plot, each 1 row x 18 feet

Stand and Bolter Counts: Beets counted in laboratory for stand
Bolters counted just before harvest

Recent Field History: Preceding crop - alfalfa

Fertilization of Beet Crop: 600 lbs. 12-12-12 per acre plowed under
250 lbs. 3-18-9 per acre with seed

Leaf Spot Exposure: Moderate

Black Root Exposure: Rather severe

Curly Top Exposure: None

Other Diseases: Possibly some Rhizoctonia

Soil and Seasonal Conditions: Soil apparently fairly uniform but uneven due to lack of levelling. Plenty of rainfall for good crop.

Cooperator: Northern Ohio Sugar Company by H. E. Brewbaker, H. L. Bush and D. Sunderland Year: 1958

Location: Glen Haas Farm, Fremont, Ohio

(Results given as 6 plot averages)

Variety	Acre Yield Sugar Recoverable[a] (lbs.)	Acre Yield Sugar Gross (lbs.)	Acre Yield Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Leaf Spot[d]	Top Vigor[e]	Rotten Beets[f] (%)	Bolters (%)	Beets per 100 ft. (No.)
SP5510-0	6116	7287	25.04	14.55	92.15	2.7	2.8	1.26	1.82	119
SP5724-0	6030	7039	23.91	14.72	93.07	2.0	2.0	0.68	0.00	123
US401	5748	6775	23.64	14.33	92.63	3.5	2.7	2.39	0.14	118
SP5481-0	5724	6747	22.84	14.77	92.60	1.5	2.2	0.71	0.28	117
SP5611-0	5425	6418	22.41	14.32	92.47	2.3	2.2	1.91	0.44	113
SP5600-01	5397	6366	22.15	14.37	92.60	2.8	2.2	0.68	0.54	123
GW674 x US401	5166	6103	21.31	14.32	92.53	3.3	2.3	1.57	0.29	117
SP5714-0	5029	5841	20.14	14.50	93.30	1.5	2.3	0.00	0.14	122
SP5615-01 MSxAm.Crys.54-604	4539	5329	17.92	14.87	92.78	5.3	3.2	1.05	0.53	127
SP566-0	4468	5332	18.11	14.72	92.08	4.0	3.7	2.24	0.14	119
Mono 91 MS x US401	4453	5337	19.24	13.87	91.93	5.5	2.8	2.01	0.00	116
SP5615-01 MS x C732	3639	4277	14.77	14.48	92.76	3.5	3.2	1.69	1.27	118
General Mean[g]	5022	5919	20.61	14.36	92.55	2.8	2.5	1.66	0.31	118
S.E. Variety Mean	-	250.51	.8371	.1680	.3788	-	-	-	-	-
S.E. Variety Mean as % of Gen. Mean	-	4.23	4.06	1.17	0.41	-	-	-	-	-
Diff. req. for Sig. (Odds 19:1)	521[b]	614	2.09	0.47	1.06	-	-	-	-	-

Variance Table

Source of Variation	DF		Mean Squares Gross Sugar[c] (lbs.)	Roots (tons)	Sucrose (%)	Purity (%)
Replicates	5		-	30.58	.9180	3.7880
Component (a)		12	-	13.10	.1833	1.4758
Component (b)		12	-	6.45	.1608	.5050
Blocks (eliminating varieties)	24		-	9.80	.1721	.9904
Varieties (ignoring blocks)	19		-	36.97	.7747	1.0368
Error (Intra-block)	71		-	4.20[h]	.1683	.8165
Error (Random Block)	95		-	5.62	.1693[h]	.8604[h]
Total	119		-	11.70	.2974	1.0116
Calculated F Value	-		-	2.97**	4.58**	NS

(a, (b, (c. See attached sheet, page 232.
(d 0 = no evidence of disease, 10 = complete necrosis
(e 1 = extremely large top, 10 = very small tops
(f Percentage of beets obviously rotten in field at time of harvest
(g General mean for 20 varieties included in complete test.
(h Error term used

AGRONOMIC EVALUATION TEST, 1958

Conducted by: H. E. Brewbaker, H. L. Bush and D. Sunderland

Location: E. S. Krauss Farm, Findlay, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 10, 1958

Date of Harvest: September 17-18, 1958

Experimental Design: Triple Rectangular Lattice

Size of Plots: 6 rows x 22 feet planted (30 inch rows)

Harvested Area per Plot for Root Yield: 6 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand and Bolter Counts: Beets counted in laboratory for stand
Bolters counted just before harvest

Recent Field History: Preceding crop - alfalfa

Fertilization of Beet Crop: Spring plowed with 500 lbs. 12-12-12 per acre plowed under
225 lbs. 6-24-12 per acre with seed

Leaf Spot Exposure: Mild. Not sufficient for readings to be made

Black Root Exposure: Moderate

Curly Top Exposure: None

Other Diseases: Possibly some Rhizoctonia

Soil and Seasonal Conditions: Fertility gradient from rather high at east part of field to weak at west end. Uneven due to lack of levelling. Rainfall sufficient for good crop.

Cooperator: Northern Ohio Sugar Co. by H. E. Brewbaker, H. L. Bush and D. Sunderland Year: 1958

Location: E. S. Krauss Farm, Findlay, Ohio

(Results given as 6 plot averages)

Variety	Acre Yield Sugar Recoverable[a] (lbs.)	Acre Yield Sugar Gross (lbs.)	Acre Yield Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Rotten[d] Beets (%)	Bolters (%)	Beets per 100 ft. (No.)
SP5510-0	3682	4957	19.02	13.03	87.45	2.01	0.83	133
SP5481-0	3563	4753	18.58	12.79	87.78	2.20	0.67	137
US401	3515	4588	17.81	12.88	88.57	0.67	0.00	137
SP5600-01	3480	4587	18.03	12.72	88.23	1.49	0.16	134
SP5714-0	3314	4278	16.29	13.13	88.98	0.99	0.17	135
SP566-0	3280	4477	17.46	12.82	86.98	2.36	0.00	113
SP5611-0	3129	4193	16.25	12.90	87.62	1.68	0.33	139
SP5724-0	3096	4110	16.22	12.67	87.95	2.72	0.16	147
Mono 91MS x US401	3077	4100	15.98	12.83	87.82	2.17	0.17	123
GW674 x US401	3026	3994	16.04	12.45	88.18	1.36	0.33	147
SP561501 MS x C732	2892	3770	14.41	13.08	88.62	1.40	0.50	119
SP561501-MS x Am. Crys.54-604	2856	3810	14.86	12.82	87.77	1.67	0.68	130
General Mean[e]	3194	4237	16.64	12.73	88.00	1.49	0.22	129
S.E. Variety Mean	-	177.50	.6492	.1956	.4867	-	-	-
S.E. Variety Mean as % of Gen. Mean	-	4.19	3.90	1.54	0.55	-	-	-
Diff. req. for Sig. (Odds 19:1)	399[b]	529	1.96	0.55	1.37	-	-	-

Variance Table

Source of Variation	DF		Mean Squares Gross Sugar[c] (lbs.)	Roots (tons)	Sucrose (%)	Purity (%)
Replicates	5		-	113.42	1.5340	3.8560
Component (a)		12	-	4.97	.0942	.6342
Component (b)		12	-	5.38	.2275	1.7367
Blocks (eliminating varieties)	24		-	5.15	.1608	1.1854
Varieties (ignoring blocks)	19		-	9.00	.3263	2.0174
Error (Intra-block)	71		-	2.53[f]	.2527	1.5006
Error (Random Block)	95		-	3.46	.2295[f]	1.4209
Total	119		-	8.94	.2997	1.6185
Calculated F Value	-		*	3.56**	NS	NS

(a, (b, (c See attached sheet, page 232.
(d Percentage of beets obviously rotten in field at time of harvest
(e General mean for 20 varieties included in complete test
(f Error term used

AGRONOMIC EVALUATION TEST, 1958

Conducted by: H. E. Brewbaker and H. L. Bush

Location: Wm. Kroskob Farm, Fort Morgan, Colorado

Cooperation: Great Western Sugar Company

Date of Planting: April 2, 1958

Date of Harvest: October 21, 1958

Experimental Design: Latin Square

Size of Plots: 6 rows x 22 feet planted (22 inch rows)

Harvest Area per Plot for Root Yield: 6 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand and Bolter Counts: Beets counted in laboratory for stand.
No bolters developed.

Recent Field History: 1956 alfalfa, 1957 potatoes fall plowed

Fertilization of Beet Crop: 20 tons manure per acre plowed under
150 pounds per acre 21-53-0 broadcast before planting

Leaf Spot Exposure: Only slight development

Black Root Exposure: None noted

Curly Top Exposure: None noted

Other Diseases: Both root-knot and sugar beet nematodes observed

Soil and Seasonal Conditions: Three severe hail storms plus nematodes contributed to poor yield on this potentially 25 tons per acre field.

Cooperator: Great Western Sugar Co. by H. E. Brewbaker and H. L. Bush Year: 1958

Location: Wm. Kroskob Farm, Fort Morgan, Colorado

(Results given as 6 plot averages)

Variety	Acre Yield: Sugar: Recoverable[a] (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Beets per 100 ft. (No.)
GW674	3479	4162	13.53	15.38	91.92	98
SP5510-0	2879	3588	12.88	13.93	90.30	85
SP5724-0	2389	2986	11.16	13.38	90.20	89
SP5481-0	2325	2992	11.57	12.93	89.10	90
SP566-0	1963	2435	8.35	14.58	90.45	74
SP5714-0	1719	2188	8.73	12.53	89.55	78
General Mean	2459	3045	11.04	13.79	90.25	86
S.E. Variety Mean	-	127.57	.5594	.3192	.4721	-
S.E. Variety Mean as % of Gen. Mean	-	4.19	3.49	2.32	0.52	-
Diff. req. for Sig. (Odds 19:1)	301[b]	376	1.65	0.94	1.39	-

Variance Table

Source of Variation	DF	Mean Squares: Gross Sugar[c] (lbs.)	Roots (tons)	Sucrose (%)	Purity (%)
Rows	5	-	7.78	7.2320	32.4980
Columns	5	-	4.58	.6460	.9000
Varieties	5	-	26.94	6.8000	5.5620
Error	20	-	1.88	.6110	1.3365
Total	35	-	6.71	2.4460	6.3294
Calculated F Value	-	-	3.78*	11.13**	4.16**

(a,(b,(c See attached sheet for footnotes, page 232.

AGRONOMIC EVALUATION TEST, 1958

Conducted by: H. E. Brewbaker and H. L. Bush

Location: Great Western Sugar Co., Exp. Station Farm, Longmont, Colorado

Cooperation: Great Western Sugar Co.

Date of Planting: April 4, 1958

Date of Harvest: October 4, 1958

Experimental Design: Latin Square

Size of Plots: 6 rows x 22 feet planted (22 inch rows)

Harvested Area per Plot for Root Yield: 6 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand and Bolter Counts: Beets counted in laboratory for stand
Bolters counted August 25

Recent Field History: 1956 corn, 1957 barley fall plowed

Fertilization of Beet Crop: 150 lbs. per acre ammonium nitrate and
150 lbs. per acre treble super-phosphate plowed under

Leaf Spot Exposure: Very mild and spotty, not severe enough for readings.

Black Root Exposure: None noted

Curly Top Exposure: Rather severe (see data sheet for readings)

Other Diseases: Some virus yellows observed, also some sugar beet nematode.

Soil and Seasonal Conditions: Curly top disease coupled with some small nematode spots contributed to high variability in this field.

Cooperator: Great Western Sugar Co. by H. E. Brewbaker and H. L. Bush   Year: 1958

Location: Great Western Sugar Co. Exp. Station Farm, Longmont, Colorado

(Results given as 6 plot averages)

Variety	Acre Yield Gross Sugar (lbs.)	Acre Yield Roots (tons)	Sucrose (%)	Top Vigor[d]	Curly Top[e]	Bolters (%)	General Appearance[f]	Crown[g]	Sprangling[h]	Beets per 100 ft. (No.)
GW674	6063	20.95	14.47	1.3	2.8	0.00	3.7	3.4	3.7	109
SP5510-0	5528	20.28	13.63	2.3	2.0	0.34	4.6	4.3	5.2	108
SP5481-0	5504	19.90	13.83	2.0	2.7	0.09	4.5	3.7	5.0	107
SP5724-0	5225	19.07	13.70	2.2	2.8	0.09	4.3	4.0	4.6	106
SP5714-0	4909	17.25	14.23	2.5	2.8	0.00	4.5	4.4	4.7	106
SP566-0	4125	15.30	13.48	2.8	3.0	0.00	4.7	4.3	4.7	101
General Mean	5220	18.79	13.89	2.2	2.7	-	-	-	-	106
S.E. Variety Mean	191.73	.5716	.2873	-	-	-	-	-	-	-
S.E. Variety Mean as % of Gen. Mean	3.67	3.03	2.07	-	-	-	-	-	-	-
Diff. req. for Sig. (Odds 19:1)	566[b]	1.69	0.85	-	-	-	-	-	-	-

Variance Table

Source of Variation	DF	Mean Squares: Gross Sugar[c] (lbs.)	Roots (tons)	Sucrose (%)
Rows	5	-	4.37	1.3580
Columns	5	-	0.55	.4460
Varieties	5	-	27.25	.8660
Error	20	-	1.96	.4950
Total	35	-	5.71	.6643
Calculated F Value	-	-	3.73*	NS

(b ,(c See attached sheet, page 232.
(d 1 = extremely large tops, 10 = very small tops
(e 0 = no evidence of disease, 10 = beets killed by curly top
(f 1 = good clean roots, 10 = very undesirable appearance
(g 1 = low, smooth crown, 10 = high, large crown
(h 0 = no sprangled, 10 = extremely bad sprangling

Cooperator: Great Western Sugar Co. by H. E. Brewbaker, R. R. Wood, H. L. Bush   Year: 1958

Location: Montana-Wyoming

(Results given as 9 plot averages)

Variety	Acre Yield: Sugar: Recoverable[a] (lbs.)	Acre Yield: Sugar: Gross (lbs.)	Acre Yield: Roots (tons)	Sucrose (%)	Thin Juice App. Purity (%)	Bolters (%)	Beets per 100 ft. (No.)
Alec Bangert Farm, Billings, Montana							
Klein E	3614	4473	16.30	13.72	90.58	0.00	117
SLC20 (Mono Klein E)	3563	4312	14.94	14.43	91.48	0.00	117
Mean[d]	3456	4245	14.99	14.16	90.91	0.10	-
Sm	-	106.32[c]	.3367	.1547	.2291	-	-
Sm/Gen. M. (%)	-	2.50	2.25	1.09	0.25	-	-
LSD 5% pt.	249[b]	306	0.95	0.48	0.68	-	-
Floren Peterson Farm, Chinook, Montana							
Klein E	7950	9196	27.37	16.80	93.34	0.00	142
SLC20 (Mono Klein E)	7299	8305	24.44	16.99	94.11	0.15	148
Mean[d]	7113	8197	24.26	16.90	93.52	0.35	140
Sm	-	196.07[c]	.5433	.1450	.3326	-	-
Sm/Gen. M. (%)	-	2.39	2.23	0.86	0.36	-	-
LSD 5% pt.	480[b]	553	1.53	0.41	0.94	-	-
Big Horn Sub-Station, Powell, Wyoming							
Klein E	5038	5506	15.50	17.76	96.04	-	92
SLC20 (Mono Klein E)	4842	5249	14.76	17.78	96.47	-	95
Mean[d]	4891	5337	14.89	17.92	96.16	-	92
Sm	-	214.90	.5868	.1436	.1884	-	-
Sm/Gen. M. (%)	-	4.03	3.95	0.80	0.20	-	-
LSD 5% pt.	739[b]	806	2.21	0.54	0.71	-	-

(a, (b, (c See attached sheet, page 232.

(d . Mean for 9 varieties in complete test

(a <u>Recoverable Sugar</u>

A technique, whereby thin juice purity could be determined from small samples was first used in 1953, following methods recently developed in the G.W. Research Laboratory at Denver. Using the resultant purity figure, a calculated "Recoverable Sugar" is obtained. An example of the calculation is as follows:

Sugar in beets = 12.00%
Standard total losses = 0.30%
Sugar on beets at sugar end = 12.00 - 0.30 = 11.70%

Assume standard molasses purity = 62.5%
100.0 - 62.5 = 37.5% Impurities on solids in molasses

$\frac{62.5}{37.5}$ = 1.6667% Sugar on impurities in molasses

Sugar sacked

85% purity thin juice = 15% impurities

$\frac{15}{85}$ = 17.6471% impurities on sugar

Sugar end = 11.70 x 17.6471% = 2.06471% on beets
Molasses produced = 2.06471 x 1.66667 = 3.4413% on beets
Sugar sacked = 12.00 - (0.30 + 3.4413) = 8.2587%

Recoverable sugar = $\frac{8.2587}{12.00}$ = 68.82%

(b <u>Approximation</u> - Calculated as percentage of "difference required for significance for "gross" sugar on basis of relationship between general means for "Gross" and "Recoverable" sugar.

(c <u>Calculated from the formula</u>:

$$S \text{ lbs. sugar} = \sqrt{\left(\frac{S \text{ lbs. beets}}{\text{Mean lbs. beets}}\right)^2 + \left(\frac{S \text{ \% sugar}}{\text{Mean \% sugar}}\right)^2}$$

Hollandale U.S.D.A. Cooperative Test - 1958

Description	Variety	Acre-Yield Gross Sugar pounds	Roots tons	Sucrose percent	Plants Per 100' Row number
Root Rot - Leaf Spot Resistant	Acc. 1402	6015	23.72	12.68	77.1
Hungarian Beet Seed	Saras H9	5934	21.64	13.71	69.5
Root Rot - Leaf Spot Resistant	SP 5724-0	5899	23.19	12.72	78.6
US #401	Acc. 1400	5560	22.03	12.62	72.9
Root Rot - Leaf Spot Resistant	Acc. 1401	5477	21.81	12.54	80.1
Commercial (536)	Am #3 S	5410	21.20	12.76	71.5
Root Rot - Leaf Spot Resistant	SP 5714-0	5312	20.29	13.09	77.4
Root Rot - Leaf Spot Resist. Mono.	Acc. 1405	4944	18.53	13.34	76.2
General Mean		5573	21.55	12.93	75.4
S. E. Variety Mean		164.6	.60	.12	2.43
" " " as % of Gen. Mean		8.35%	7.92%	2.66%	9.14%
Diff. Req. for Sig. (Odds 19:1)		469	1.72	.35	6.96

Source of Variation	D/F	Mean Squares: Gross Sugar a/ (lbs.)	Roots (tons)	Sucrose Percent	Plants Per 100' Row
Columns	7	-	269.59	0.357	167.57
Blocks	7	-	47.33	0.649	54.14
Varieties	7	-	1658.72	1.354	123.00
Error	42	-	227.97	0.118	52.45
Total	63				
Calculated F. Value		-	7.28**	11.47**	2.34*

a/ Calculated from the formula:

$$\text{SE lbs. Sugar} = \text{Mean lbs. Sugar} \sqrt{\left(\frac{\text{SE lbs. Beets}}{\text{Mean lbs. Beets}}\right)^2 + \left(\frac{\text{SE \% Sugar}}{\text{Mean \% Sugar}}\right)^2}$$

*Significant at the 5% level
**Significant at the 1% level

Comments:

Planted on Mr. Henry Ravenhorst's Farm and conducted by Mr. Donald Farus.

Latin Square test, 8 x 8. Plots 3 rows wide, 35 feet long. Planted May 1, 1958; harvested September 25, 1958. The center row was harvested and divided into two samples for sucrose determinations. All three rows were harvested for yield.

Field history and fertilization: Beets 1954; potatoes 1955; beets 1956; potatoes 1957; beets 1958. There was 400 pounds of 0-12-36 spring broadcast and 250 pounds of 5-20-20 applied at planting time.

Soil Type: Marl.

Diseases: Some scattering of Rhizoctonia but of little importance, also very little leaf spot.

Reliability: Although some differences were detected for stand, the test can be considered reliable.

Notes: The variety Saras H9 was received from Hungary and supposedly has some leaf spot resistance.

HOLLY SUGAR CORPORATION

VARIETY TEST 1958 SWINK, COLORADO

U.S.D.A. - L.S.R. GROWER: MITSUO YAGAMI

Variety	Source	Acre Yield Gross Sugar	Acre Yield Tons Beets	Percent Sucrose	No. beets 100' row
HH 1	361HO x H 56-55	6761	22.582	14.97	106
SP5611-0	Lot 7337	5504	18.953	14.52	107
SP55600-01	Lot 7324	5201	18.858	13.79	109
SP5724-0	Synthetic	5137	18.693	13.74	107
SP5512-0	Lot 7320	5098	17.617	14.47	114
Acc. 1400	US 401	5019	17.674	14.20	112
Acc. 1401	SP5481-0	5015	18.079	13.87	112
Acc. 1402	SP5510-0	4986	18.080	13.79	114
SP5713-0	D. Stewart	4959	16.822	14.74	113
SP5714-0	SP5614-0	4582	15.715	14.58	109
SP555-0	U-I	4298	16.003	13.43	118
SP554-0	U-I	4132	16.026	12.89	108
SP5651-0	U-I	3989	15.270	13.06	111
SP55-206-0	Lot 7206	3959	13.058	15.16	110
SP558-0	Lot 7208	3779	13.516	13.98	108
Acc. 1405	SP566-0	3475	12.860	13.51	107
SP557-0	Lot 7207	3432	13.011	13.19	103
Gen. Mean		4666	16.636	13.99	110
S.E. Mean		210 a/	.627	.34	
Sig. Diff. (5%)		586	1.755	.96	
S.E.M/Gen. Mean (%)		4.49	3.77	2.44	

VARIANCE TABLE

Source of Variation	Degrees of Freedom	Mean Squares Tons Beets	Mean Squares Percent Sucrose
Replications	8	269.65	15.89
Varieties	16	61.62	4.05
Residual	128	3.54	1.05
Total	152	23.66	2.15
Calc. F Value		17.41**	3.85**

** Exceeds the 1% point of significance 2.14

a/ SM calculated from formula.

Plot size: 3 rows (20") x 39' planted; 3 rows x 35' harvested.
Design: Randomized block.
Date planted: April 15, 1958; harvested: Oct. 16, 1958.
Two 10-beet samples taken for sucrose analysis.
Previous crops: Alfalfa 5 years. Spring plowed.
Fertilizer applied: 200 lbs. per Acre Ammonium Nitrate and 300 lbs per Acre of T.S.P.
Remarks: Results from this test are considered reliable.

1958 COOPERATIVE EVALUATION TEST OF SUGAR BEET VARIETIES

Rocky Ford, Colorado

Cooperation: Colorado Agricultural Experiment Station.

Conducted on the Arkansas Valley Branch Experiment Station
by Jerre F. Swink, Superintendent.

Comments:

Latin Square Test, 8 x 8. Plots 4 rows wide (22 inch rows), 35 feet long. Planted April 16, 1958; harvested October 21, 1958. Two inner rows of each plot were harvested from a total row length of 70 feet. Two ten-beet samples were taken at random from the harvested section of each plot after lifting and topping.

Field history and fertilization: Small grain in 1954; alfalfa in 1955 and 1956; potatoes in 1957 with 500 pounds of 6-24-6 applied; sugar beets in 1958; there was 300 pounds per acre of 6-24-6 applied prior to planting; 100 pounds per acre of 20-53-0, built up with 100 pounds of ammonium nitrate (33.3-00) was added to the irrigation water.

Soil type: Rocky Ford Clay Loam.

Diseases: Cercospora Leaf spot was severe to moderate over the complete test. Readings, using a scale from 0 (no infection) to 5 (completely dead), were taken September 10, 1958. At harvest time symptoms of curly-top virus also was present. An estimate of 10 percent of the beets were infected. Strain Acc. 1405 appeared to be more susceptible than the others.

Reliability: Results are considered quite reliable.

Notes: Similar tests as this one have been conducted at the Arkansas Valley Branch Station for the past several years. In the majority of these tests the commercial variety, American #2 has out-yielded the other strains. In this test Acc. 1402 was significantly higher than American #2 in tonnage and pounds sugar per acre. Some of the losses in yield of American #2 can be contributed to the severe epiphytotic of leaf spot.

The bottom two ranking strains were monogerm varieties. It is quite obvious that they are not ready for commercial production. It also should be pointed out that the stand of the bottom ranking strain Acc. 1405 was the poorest for all varieties. There was some stand reduction in this strain due to disease factors, however at harvest time, there was still a sufficient number of well spaced beets for this variety to reach its potential yield under the conditions of this test.

1958 COOPERATIVE EVALUATION TEST OF SUGAR BEET VARIETIES

Rocky Ford, Colorado

Description	Variety	Acre-Yield Gross Sugar	Roots	Sucrose	Plants Per 100' Row	Leaf Spot Reading
		pounds	tons	percent	number	
Root Rot-Leaf Spot Resist.	Acc. 1402	7440	26.79	13.9	125.4	2.6
Root Rot-Leaf Spot Resist.	SP 5724-0	7309	24.86	14.7	123.7	1.7
Root Rot-Leaf Spot Resist.	Acc. 1401	6936	24.25	14.3	124.5	1.7
Root Rot-Leaf Spot Resist.	Am #2	6875	24.04	14.3	126.4	3.6
Root Rot-Leaf Spot Resist.	SP 5714-0	6853	23.96	14.3	121.1	1.7
US #401	Acc. 1400	6493	23.19	14.0	127.4	1.7
Am #2 Monogerm	57-413	5976	21.97	13.6	132.2	3.7
Root Rot-Leaf Spot Res. Mono.	Acc. 1405	5570	20.33	13.7	118.8	3.6
General Mean		6675	23.67	14.1	124.5	2.7
S. E. Variety Mean		199.9	0.64	0.19	3.23	0.24
" " " as % of Gen. Mean		6.4%	7.57%	3.83%	7.32%	25.56%
Diff. Req. for Sig. (Odds 19:1)		570	1.81	0.55	NS	0.67

Source of Variation	D/F	MEAN SQUARES: Gross Sugar a/ (lbs.)	Roots (tons)	Sucrose Percent	Plants Per 100' Row	Leaf Spot Reading
Columns	7	-	260.5	0.80	33.42	.2857
Blocks	7	-	39.3	1.73	37.28	.2857
Varieties	7	-	1032.9	1.03	64.28	6.4285
Error	42	-	111.5	0.29	41.02	.4762
Total	63					
Calculated F. Value		-	9.26**	3.54**	1.56	13.49**

a/ Calculated from the formula:

$$\text{SE lbs. Sugar} = \text{Mean lbs. Sugar} \sqrt{\left(\frac{\text{SE lbs. Beets}}{\text{Mean lbs. Beets}}\right)^2 + \left(\frac{\text{SE \% Sugar}}{\text{Mean \% Sugar}}\right)^2}$$

** Significant at the 1% level

COOPERATIVE AGRONOMIC EVALUATION TEST - 1958
Fort Collins Experiment No. 1A

Conducted by: J. O. Gaskill and J. A. Elder.

Location: Hospital Farm, Fort Collins, Colorado; Field number 3, under sprinkler.

Cooperation: Colorado Agricultural Experiment Station and Board of County Commissioners of Larimer County.

Date of Planting: May 12.

Date of Harvest: October 6.

Experimental Design: Latin Square, 8 x 8.

Size of Plots: Four rows x 24'; rows 20" apart.

Harvested Area per Plot for Root Yield: Two inner rows x 21'; all roots topped, washed, and weighed.

Samples for Sucrose Determinations: One 22-beet sample was taken at random from the harvest section of each plot, after lifting, and before piling and topping. Pulp from all roots of any given sample was composited. Duplicate sucrose determinations were made, with a third determination in case the first two failed to agree satisfactorily.

Stand and Bolter Counts: Actual counts were made in the 2 inner rows x 21', in each plot, on September 19.

Recent Field History: 1953, sugar beets; 1954-57, alfalfa; plowed 8/29/57; barley planted on 8/30/57 for green manure crop, and plowed under 11/12-15/57.

Fertilization of Beet Crop: Approximately 200 lbs. treble superphosphate, per acre, applied on 8/28/57, just before plowing.

Leaf Spot Exposure: Severe.

Black Root Exposure: Negligible.

Curly Top Exposure: Curly top symptoms began to appear soon after thinning, and the percentage of infected plants apparently increased gradually until the latter part of the season. Root yields obviously were reduced somewhat by the disease, but stands were not affected materially.

Other Diseases: Negligible.

Soil and Seasonal Conditions: Soil type -- Fort Collins Loam, light textured phase, or Fort Collins Fine Sandy Loam. The crop was sprayed or dusted 5 times with Parathion and Toxaphene, chiefly for control of the beet leafhopper (and curly top). The weather was not far from normal. Furrow irrigation was adequate. The crop was inoculated (*Cercospora beticola*) by means of a power sprayer on July 22, using a spore suspension prepared from leaves collected from the 1957 crop. Following inoculation, daily light sprinkling with water (usually in evening, only) was employed, until the end of August, to promote leaf spot development.

Reliability of Test: Satisfactory except for curly top. The varieties differed quite significantly in percentage of obvious curly top near time of harvest. These differences must be kept in mind when making varietal comparisons, particularly in yield of roots and gross sucrose.

COOPERATIVE AGRONOMIC EVALUATION TEST
EXPERIMENT NO. 1A - 1958, FORT COLLINS, COLORADO (UNDER SPRINKLER)
(Results given as 8-plot averages)

Description	Seed No.	Entry No.	Foliage Notes a/ Leaf Spot 8/29	Leaf Spot 9/9	U	S	C	Stand (Hills per 100')	Bolters	Curly Top b/	Harvest Results: Rts. per plot	Root Yield per A.	Sucrose	Gross Sucrose per A.
								no.	%	%	no.	tons	%	lbs.
SP 5614-0 (syn. variety from clones); SP 5714-0	Acc.2170	1	1.0	2.0	5.3	6.0	5.3	112.9	0.00	34.6	46	10.93	15.58	3410
7 syn. varieties, largely from clones or selfed progenies of superior mothers; SP 5724-0	" 2171	2	1.1	2.2	5.0	6.3	5.3	115.4	0.00	18.4	48	12.45	14.98	3733
SP 5510-0 (syn. variety from clones); WC 7370	" 1402	3	1.5	3.2	4.5	5.4	4.8	115.5	0.00	6.0	48	13.25	14.78	3919
SP 5481-0 (from polycrosses); WC 7328	" 1401	4	1.5	2.4	5.0	5.9	4.9	114.6	0.00	17.0	47	12.70	14.85	3775
US 401; WC 7359	" 1400	5	2.2	3.4	5.1	5.5	5.1	111.6	0.00	16.4	47	12.33	14.37	3533
SP 566-0 (pool of 10 mm progenies); WC 7209	" 1405	6	2.2	3.4	5.6	4.9	4.8	110.0	0.00	23.8	44	9.48	14.33	2718
European Check (486-0); WC 3216	" 1327	7	5.0	6.0	5.5	4.0	6.0	110.8	0.28	19.6	45	11.75	13.63	3197
Local Check; GW 674-56C	" 2168	8	1.6	3.3	5.8	6.1	5.8	112.4	0.00	24.3	46	13.73	15.15	4160
General Mean								112.89		19.99		12.0777	14.7089	3555.53
S. E. of Variety Mean								1.521		2.398		0.2650	0.1494	86.93
S. E. of Variety Mean as % of General Mean								1.35		12.00		2.19	1.02	2.44
L. S. D. (odds 19:1)								4.3		6.8		0.76	0.43	248

Variance Table

Source of Variation	D/F	Mean Square (Variance): Stand (Hills per 100')	Curly Top (%)	Root Yield per Acre (tons)	Sucrose (%)	Gross Sucrose per Acre (lbs.)
Rows	7	68.98	49.53	1.6231	0.8507	129,351.1
Columns	7	18.02	194.31	0.3972	0.6098	94,428.4
Varieties	7	35.19	533.91	14.7028	2.8249	1,634,109.3
Error (remainder)	42	18.50	45.99	0.5617	0.1785	60,452.3
Total	63					
Calculated F value c/		1.90	11.61**	26.18**	15.83**	27.03**

a/ Foliage Notes (8/29/58 except 2nd set of leaf spot readings):
Leaf Spot: 0 = no leaf spot; 10 = complete defoliation.
Uniformity: low no. = uniform; high no. = irregular (in size, type, and color).
Size: low no. = small; high no. = large. Color: low no. = light green; high no. = dark green.

b/ Plants with definite foliage symptoms of curly top, 9/22 - 23/58 (2 inner rows x 21' in each plot).

c/ Symbols used to indicate significance of F values:
*: F equal to or greater than 5% point.
**: F equal to or greater than 1% point.

OBSERVATIONAL TEST OF BREEDER SEED OF SYNTHETIC VARIETIES CARRYING RESISTANCES TO LEAF SPOT, BLACK ROOT, AND CURLY TOP

Leaf Spot Sprinkler Field, Hospital Farm, Fort Collins, Colorado

Experiment No. 2A - 1958

(Results given as 4-plot averages)

Description	Immed. Par. or Contrib. No.	F.C. Seed No.	Entry No.	Leaf Spot a/ 8/27-29	Leaf Spot a/ 9/8	Other Fol. Read. b/ U	Other Fol. Read. b/ S	Other Fol. Read. b/ C	Remarks
US 401	WC 7359	Acc.1400	101	2.5	3.0	5.8	6.0	5.0	
SP 5481-0 (from p.c.)	WC 7328	" 1401	102	1.9	2.4	5.8	6.0	5.0	
SP 5510-0 (" clones)	WC 7370	" 1402	103	1.8	2.5	5.3	5.8	5.0	
SP 5611-0 (" ")	WC 7337	" 1411	104	2.4	2.9	5.5	5.8	5.0	
SP 5512-0 (" ")	WC 7320	" 1412	105	2.3	2.6	5.5	6.0	4.8	
Syn. var. (" ")	SP 5713-0	" 2172	106	1.3	1.3	5.5	5.8	5.0	
" " (" ")	SP 5714-0	" 2170-a	107	1.8	2.0	5.8	6.0	5.0	
" " (" ")	SP 5716-0	" 2173	108	1.6	2.0	5.8	6.8	4.8	
Broad base syn. var.	SP 5724-0	" 2171-a	109	1.6	2.1	6.0	6.3	5.3	
Syn. var. (from p.c.)	SP 57365-01	" 2174	110	1.1	1.8	5.8	6.3	5.0	
" " (" " ")	SP 573566-01	" 2175	111	1.9	2.8	6.0	6.0	5.5	
SP 55600-01 (from p.c.)	WC 7324	" 1409	112	2.6	2.9	6.0	6.0	5.3	
SP 5460-0 (" " ")	WC 6327	" 1410	113	1.3	2.1	5.3	6.3	5.3	
LS-CT res.	U-I(SP 554-0)	" 1416	114	4.3	5.5	5.5	5.5	6.0	
" " "	" (" 555-0)	" 1417	115	2.6	5.4	4.3	5.0	6.0	
" " "	" ("5551-0)	" 1418	116	2.8	4.4	5.0	5.5	5.8	
Syn. var., LS-CT Res. (from clones)	SP 57108-0	" 2176	117	2.1	3.9	4.3	5.3	6.0	
Syn. var., LS-CT Res. (sel. at Jerome)	SP 57109-0	" 2177	118	1.8	4.3	4.8	5.8	5.8	
SP 557-0 (monogerm)	WC 7207	" 1403	119	2.8	2.8	5.5	5.5	5.3	mm
SP 558-0 (")	WC 7208	" 1404	120	1.5	2.5	5.3	6.0	5.3	mm
SP 566-0 (")	WC 7209	" 1405	121	2.1	3.0	6.0	5.3	5.0	mm
(610x91) 91 x SP 5460-0	A.C.S. Co. (monogerm)	" 1398	122	2.8	4.0	5.3	6.0	5.0	Monogerm seed (Mm)
SL 108 ms x SP 5460-0	WC 7316	" 1420	123	2.8	3.8	5.8	6.3	5.5	
SP 5515-01 ms x SP 5460-0 " " " " x US 401	WC 6203F & WC 6206F	" 1396	124	2.8	2.9	6.3	6.0	5.5	
US 400	WC 4441	" 2056	125	2.9	3.9	5.4	5.6	5.5	8-plot Aver.
Acc. 1329 (US 400)	Clones V-34, 37, & 47	SP 571101-0	126	1.3	1.9	5.5	6.0	4.5	
US 201 rr	551026-0	SP571002-0	127	0.8	1.4	5.5	5.8	6.0	
1958 "Local Ck."	GW674-56C	Acc.2168	128	2.3	2.8	6.5	6.0	6.0	
Syn. ck. (486-0)	WC 3216	" 1327	129	5.3	6.3	6.0	4.0	5.8	
471001-0	WC 9323	" 1358	130	5.3	6.5	6.0	3.8	5.3	
R & G Pioneer, MM (L.S. susc. ck.)		" 6023	P	4.4	6.0	5.8	4.5	6.0	

a/ Leaf spot readings (J. A. Elder): 0 = no leaf spot; 10 = complete defoliation. The readings of 9/8 were made at "peak stage" of the epidemic and are considered more meaningful than the readings of 8/27-29.

b/ Other foliage readings (J. A. Elder): (8/27-29)
Uniformity: Low no. - uniform; high no. = irregular (in size, type, and color).
Size: Low no. = small; high no. = large.
Color: Low no. = light green; high no. = dark green.

Field plan:
Plots 2 rows x 12'; 4 replications, except for Acc. 2056 which occurred in 8 plots. Artificial inoculation and frequent sprinkling used to promote leaf spot development.

Remarks:
Except for the varieties with known curly top resistance (entry numbers 114, 115, 116, 117, 118, 122, and 123), the curly top disease was quite prevalent in this test. Such plants were disregarded insofar as possible, in making readings, and reliability of the test is considered acceptable.

OBSERVATIONAL TEST OF NEW ACCESSIONS AND MISCELLANEOUS NEW [redacted] LOTS

Leaf Spot Sprinkler Field, Hospital Farm, Fort Collins, Colorado

Experiment No. 5A, 1958

Description	Immed. Par. or Contrib. No.	F.C. Seed No.	Entry No.	Leaf Spot a/ 8/27	Leaf Spot a/ 9/5-8	Other Fol. Read. 8/27 b/ U	S	C	No. of plots	c/
Monogerm syn. var.	SP 5832-0	Acc.2197	69	1.6	2.1	5.8	6.0	5.0	4	
Hilleshog; 4n; from Rasmussen	H 3611	"	70	3.0	4.5	5.0	5.0	6.0	2	
US 201 rr	451006-0	501007-0	71	0.5	0.5	5.0	5.3	6.3	4	
US 201; 501007-0	541001-0	571001-0	72	0.5	0.8	5.0	5.5	6.0	4	
do	551026-0	571002-0	73	0.9	1.3	5.8	6.3	6.0	4	
51-319 RR x US 201 rr	L.R.P. no. 56-6346	571008-0(F_2)	74	3.0	5.0	7.0	4.5	5.5	2	*
do	L.R.P. no. 56-6442	571009-0(F_2)	75	3.0	4.5	5.5	3.5	6.0	2	
51-319 RR x US 201 rr	L.R.P.56-6442♀ x	571819-01	76	2.5	3.5	6.0	4.5	6.0	2	*
US 201 rr	L.R.P.56-6433♀	571819-02 d/	77	0.8	1.0	5.0	5.0	5.0	2	
51-319 RR x US 201 rr	L.R.P.56-6442♀ x	571818-01	78	3.5	4.0	6.0	5.0	6.0	2	*
52-334 (pink rt.)	L.R.P.56-6422♀	" -02	79	3.0	4.0	5.5	4.0	5.5	2	*
Dem. inb. (RR,globe, white rt.)	51-319	561017-0	80	7.0	7.5	6.0	1.5	5.0	2	*
Dem.inb.(RR,~~xxxxx~~ pink rt.)	52-334	561018-0	81	4.5	5.0	4.0	4.0	4.0	2	*
LS-BR res.; 50A3-00	WC 1275	Acc.1339	82	3.0	4.0	5.8	6.0	5.0	4	
Bot. res. sel. from Acc.1192 (WC 1275)	4 strains	571102-00	83	3.0	3.3	6.3	6.3	5.3	4	
do	do	571801-00	84	2.3	2.9	5.8	6.0	5.0	4	
SP 5481-0 (LS-BR res.)	WC 5214	Acc. 2066	85	1.3	2.0	5.3	6.5	4.8	4	
do	do	" 2191	86	1.4	2.1	5.8	6.3	4.5	4	
do (Bot. res. sel.)	Acc.2066	571103-0	87	1.6	2.0	5.5	6.0	5.3	4	
Bot. res. syn. var.	551609-0	571104-0	88	2.8	3.5	5.5	6.0	5.5	2	
SP 5615-01 MS ♀ x SP 5615-0 (?)	WC 7200F	Acc.1406	89	2.0	2.8	6.3	6.0	5.3	4	
SP 5515-01 [redacted] MS x SP 5515-0 mm	WC 6308F	" 1407	90	2.5	2.6	6.0	5.8	5.5	4	
SP 5515-0 [redacted] T.O.	WC 6307M	" 1408	91	2.5	3.0	5.5	5.0	5.3	4	*
Desprez - France	RC-1	" 1413	92	3.0	3.5	5.8	5.8	5.8	4	
do	RC-2	" 1414	93	2.5	3.6	5.8	6.0	5.5	4	
Polycross; Desprez - France	30B-RC	" 1415	94	3.5	4.0	5.5	6.0	5.5	2	
Hungarian var.	Saros H9	" 1419	95	3.0	4.3	6.3	6.0	5.5	4	*
Com. var.	GW 674-56C	" 2168	96	2.3	2.9	5.8	6.3	5.8	4	
Rhizoc.res.sel.from GW 674	C770(G.W.S.Co.)	" 2169	97	2.3	2.8	5.3	6.3	6.3	4	
471001-0	WC 9323	" 1358	98	3.4	6.5	5.5	4.3	5.3	4	
US 400	WC 4441	" 2056	99	2.3	3.4	5.9	5.9	5.0	8	
Pioneer	WC 3258	" 6023	100	3.9	6.3	6.5	4.5	6.0	4	

a/ Leaf spot readings (J. A. Elder): 0 = no leaf spot; 10 = complete defoliation. The readings of 9/5-8 were made at "peak stage" of the epidemic and are considered more meaningful than the readings of 8/27.

b/ Other foliage readings (8/27/58; J. A. Elder):
Uniformity: Low no. = uniform; high no. = irregular (in size, type, and color).
Size: Low no. = small; high no. = large.
Color: Low no. = light green; high no. = dark green.

c/ Asterisk (*) indicates that foliage readings are of questionable value, largely because of curly top.

d/ 571819-02 thinned to pink-hypocotyl stand insofar [redacted] possible (actually only about 1/6 of thinned stand was pink).

Field plan:
Plots 2 rows x 12'; 2 to 8 replications as indicated. Artificial inoculation and frequent sprinkling used to promote leaf spot development.

Remarks:
Curly top was quite prevalent in many plots. An attempt was made to base all foliage readings on non-curly top plants. Except [redacted] indicated (see footnote c), the reliability of the results given is considered acceptable.

SUGAR BEET VARIETY TEST

Conducted by Spreckels Sugar Company in Their District 2

Reported by Lauren Burtch

Liberty Island

Variety	Sug/Ac.	Tons/Ac.	% Sugar	Stand
5510-0	4,012	23.89	16.78	160
US 400	4,003	23.41	17.15	111
5612-0	3,981	23.94	16.65	163
5611-0	3,783	21.78	17.38	138
US 401	3,768	22.44	16.77	160
US 56/2	3,765	21.96	17.15	153
674 H2	3,658	20.72	17.63	135
55206-0	3,482	19.50	17.87	140
US 104	3,377	19.70	17.15	114
5651-0	3,372	20.48	16.45	146
555-0	3,362	19.97	16.87	142
LSD P=.05	0.541	2.83	0.64	
LDA P=.01	0.718	3.75	0.86	
General Mean	3,857	22.65	17.04	144
S E of Mean	0.196	1.10	0.73	
S E in % of Mean	5.09	4.87	1.37	

Pl. June 2, 1958
Harvested 10/29/58
Disease was not a factor in this test.
16 varieties x 6 replications

Arvin

663 H1	2,547	25.59	10.15	160
US 75	2,066	19.81	10.46	168
LSD P = .05	NS	3.60	NS	
LSD P = .01	NS	4.81	NS	
General Mean	2,179	21.63	10.20	167
S E of Mean	0.15	1.26	0.225	
S E in % of Mean	6.88	5.82	2.21	

Pl. 2/21/58
Harvested 11/12/58
Leaf spot was a factor inthis field. It was sprinkled irrigated and severely defoliated.

SUGAR BEET VARIETY TEST

Conducted by Spreckels Sugar Company in Their District 2

Reported by Lauren Burtch

Tudor	Sug/Ac.	Tons/Ac.	Sugar	Stand
5481-0	2,929	17.74	16.65	91
US 400	2,929	17.78	16.46	99
554-0	2,725	16.63	16.38	102
5460-0	2,551	15.30	16.74	98
US 104	2,482	15.15	16.36	90
674 H2	2,148	13.08	16.58	73
US 56/2	1,835	11.13	16.48	84
LSD P = .05	0.565	3.40	0.49	
LSD P =. 01	0.752	4.52	0.65	
General Mean	2,551	15.30	16.74	89
S E of Mean	0.200	1.15	0.17	
S E in % of Mean	7.84	7.52	1.02	

Pl. May 9, 1958
Harvested 11/4/58
Leaf spot was not present in this test. Yields were adversely arrected by the presence of Sclerotium rolfsii
10 varieties x 8 replications

Newman

Variety	Sug/Ac.	Tons/Ac.	Sugar	Stand
663 H1	2,385	14.56	16.37	111
US 22/3	2,352	14.23	16.68	126
US 75	2,120	13.12	16.18	127
LSD P = .05	NS	NS	NS	33
LSD P = .01	NS	NS	NS	NS
General Mean	2,335	14.36	16.77	121
S E Mean	0.124	1.35	0.49	12
S E in % of Mean	5.18	9.40	2.92	9.67

Pl. April 23, 1958
Harvested Oct. 14, 1958

Initial stands were affected by seedling diseases.

16 varieties x 6 replications.

STRAINS COMBINING LEAF-SPOT AND CURLY-TOP RESISTANCE
Developed at Salt Lake City with Curly-Top Selections
at Jerome, Idaho, and Salinas, California

SL NUMBER	STRAIN DESCRIPTION
701	601 aa X (720 to 730 stocks 601 = Increase [(F_2 US 35 aa X US 201) aa X US 201]
720	F_4 (US 201 X CT9) CT sel. in F_2 at Jerome, Idaho
721	Increase from CT sel. [US 201 X F_2 (US 201 X CT9)]
722	Increase of b_2 US 201 (self-fertile) X [US 201 X (US 201 X CT9)] With CT sel. in b_1 generation at Jerome, Idaho
723	do. (using Self-sterile US 201 in final backcross)
724	do. do.
725	F_2 (US 201 X US 201B-20) US 201B-20 = CT sel. on virus No. 11 by Dr. C. W. Bennett
726	F_2 (US 201B-18 X US 201B) Jerome CT sel. US 201B-18 = CT sel. on virus No. 11 by Dr. C. W. Bennett
727	F_2 (US 201B-20 X US 201B-19) Both parents = CT sel. on virus No. 11
728	F_2 (US 201B-20 Virus No. 11 sel. X US 201B Jerome CT sel.)
729	F_2 (US 104 single beet X US 201B-20 Virus No. 11 sel.)
730	F_2 (US 104 single beet (MS plasm) X US 201B-20 Virus No. 11 sel.)
731	US 201B Jerome, Idaho, CT sel. from five beets by Albert M. Murphy

Original US 201 = Fort Collins 501007-0; 1953 entry SL 3305
Original US 201B = SP 52126-0 from Dewey Stewart; 1954 entry SL 4332
Original US 104 or US 104 type = SP 5551-0137; 1955 entry SL 5303

Male sterility:

aa = Recessive condition known as Mendelian male sterility
Population SL 727 segregated for Mendelian male sterility; hence the parent plants US 201B-19 and US 201B-20 were heterozygotes, possibly of constitution Aa.
Population SL 730 segregated for male sterility and semi-male sterility probably due to cytoplasmic inheritance from the US 104 parent.

Self-fertility:

Self sterility prevailed in US 104, US 201B and for all parental US 201 beets except for the final backcrossing in production of SL 722. Here the US 201 parental beet (SL 503-15) was highly self-fertile. Self-fertility was also introduced where CT9 was used in the parentage.

STRAINS COMBINING LEAF-SPOT AND CURLY-TOP RESISTANCE
Results at Four Locations, 1958

STRAIN OR VARIETY[1/]	BELTSVILLE MD. Leaf-spot score	BELTSVILLE MD. Roots per plot	FORT COLLINS COLO. Leaf-spot score 8/26	FORT COLLINS COLO. Leaf-spot score 9/4	JEROME IDAHO % Curly-top Test A	JEROME IDAHO % Curly-top Test B	SALT LAKE CITY UTAH Roots per acre	SALT LAKE CITY UTAH Percent sucrose
		Lbs.					Tons	
SL 701 = 601 aa X (720 to 730)	4.1	3933	1.8	3.4	10	25	35.6	14.0
SL 720 = F_4 (201 X CT9)	5.1	11	2.1	5.8	7	11	28.4	11.3
SL 721 = 201 X (201 X CT9)	3.4	27	0.8	2.1	36	36	26.3	11.6
SL 722 b_2 to 201	4.1	19	0.5	2.3	75	85	21.5	14.2
SL 723 do.	4.1	95	0.9	2.0	64	78	29.9	12.7
SL 724 do.	4.1	65	1.0	2.1	41	66	27.0	12.7
SL 725 (201 X 201B-20)	4.0	42	0.5	1.9	50	44	33.1	13.5
SL 726 (201B-20 X 201)	4.2	41	1.6	3.9	32	18	28.5	14.0
SL 727 (201B-20 X 201B-19)	3.9	69	1.4	3.9	25	31	30.5	14.0
SL 728 (201B-20 X 201B)	4.0	59	1.5	3.6	35	36	34.5	12.9
SL 729 (104 X 201B-20)	5.5	79	2.4	3.0	30	16	37.2	12.3
SL 730 (104 X 201B-20)	4.2	74	0.9	2.5	10	16	36.8	13.4
SL 731 CT sel. 201B	3.7	56	1.0	3.0	27	51	24.4	14.0
Acc. 1327 Synthetic check	5.7	14						
Acc. 1400 US 401	4.7	107						
Acc.1363 US 22/4			3.9	6.0				
Acc.1119 US 226			2.0	2.8				
SP 551026-0 US 201			0.6	1.5				
SL 333 US 33						50		
SL 028 US 41					6		35.6	12.6

1/ In strain descriptions 104, 201 and 201B signify US 104, US 201 and US 201B respectively.

TEST UNDER LEAF SPOT AND BLACK ROOT EXPOSURE, BELTSVILLE, MD.
Strains Combining Leaf-Spot and Curly-Top Resistance

By Gerald E. Coe

SL NUMBER	STRAIN DESCRIPTION	FOLIAGE VIGOR SCORE	LEAF-SPOT SCORE	BEETS HARVESTED PER PLOT	ROOT WEIGHT PER PLOT Lbs.
SL 701	601 aa X (720 to 730)	2.0	4.1	45	33
SL 720	F_4 (201 X CT9)	1.0	5.1	26	11
SL 721	201 X (201 X CT9)	1.4	3.4	29	27
SL 722	b_2 to 201	1.9	4.1	26	19
SL 723	do.	2.0	4.1	57	95
SL 724	do.	2.0	4.1	48	65
SL 725	F_2 (201 X 201B-20)	1.7	4.0	42	42
SL 726	F_2 (201B-20 X 201)	1.7	4.2	43	41
SL 727	F_2 (201B-20 X 201B-19)	1.7	3.9	47	69
SL 728	F_2 (201B-20 X 201B)	1.6	4.0	41	59
SL 729	F_2 (104 X 201B-20)	2.0	5.5	49	79
SL 730	F_2 (104 X 201B-20	1.7	4.2	48	74
SL 731	201B Jerome CT sels.	1.5	3.7	58	56
Acc.1327	(Synthetic check)	2.0	5.7	23	14
Acc.1400	(US 401)	3.0	4.7	67	107

Remarks:

There were two 4-row, 20-foot plots of each strain except for SL 731 which had only one plot. Each 20 ft. row was scored individually. Foliage vigor scored on basis of 1 to 5 just before the plants came down with leaf spot; 1 = small; 4 = vigorous like US 400, and 5, exceptionally vigorous. Leaf-spot injury scored 0 to 10; 0 = 29 infection; 10= all leaves dead.

OBSERVATIONAL LEAF-SPOT TEST, FORT COLLINS, COLORADO, 1958
Strains Combining Leaf-spot and Curly-top Resistance

By J. O. Gaskill

Experiment No. 3A

STRAIN DESCRIPTION	STRAIN NUMBER	F.C. SEED NO.	LEAF SPOT[a] 8/26	LEAF SPOT[a] 9/4	OTHER FOL. READ. 8/24[b] Un.	Size	Col.
601 aa X (720 to 730)	SL 701	Acc.2178	1.8	3.4	4.5	5.5	5.5
F_4 (201 X CT5)	SL 720	Acc.2179	2.1	5.8	4.0	4.0	5.0
201 X (201 X CT9)	SL 721	Acc.2180	0.8	2.1	4.8	6.0	5.5
b_2 to 201	SL 722	Acc.2181	0.5	2.3	5.0	6.3	5.0
do.	SL 723	Acc.2182	0.9	2.0	5.0	6.0	5.8
do.	SL 724	Acc.2183	1.0	2.1	5.5	6.0	5.8
F_2 (201 X 201B-20)	SL 725	Acc.2184	0.5	1.9	5.3	5.8	6.0
F_2 (201B-20 X 201)	SL 726	Acc.2185	1.6	3.9	4.5	5.3	5.3
F_2 (201B-20 X 201B-19)	SL 727	Acc.2186	1.4	3.9	5.5	5.5	5.8
F_2 (201B-20 X 201B)	SL 728	Acc.2187	1.5	3.6	5.0	5.3	5.0
F_2 (104 X 201B-20)	SL 729	Acc.2188	2.4	3.0	5.8	5.0	6.0
F_2 (104 X 201B-20)	SL 730	Acc.2189	0.9	2.5	4.8	5.5	6.0
US 201B Jerome CT sels.	SL 731	Acc.2190	1.0	3.0	4.5	5.8	5.8
US 22/4	SL 92	Acc.1363	3.9	6.0	5.0	4.8	5.8
US 226	WC 8324	Acc.1119	2.0	2.8	5.8	5.8	5.3
US 201 rr	SP 551026-0	571002-0	0.6	1.5	5.5	5.3	6.0

a/ Leaf-spot readings (J. A Elder): 0 = no leaf spot;
10 = complete defoliation
The readings of 9/4 were made at "peak stage" of the epidemic and are considered more meaningful than the readings of 8/26.

b/ Other foliage readings (J. A. Elder):
Uniformity: Low No. = uniform; High No. = irregular (in size, type and color)
Size: Low No. = small; High No. = large;
Color: Low No. = light green; High No. = dark green

Field plan: Plots 2 rows X 12'; 4 replications. Artificial inoculation and frequent sprinkling used to promote leaf-spot development.

Remarks: Considerable curly-top (up to about 3/4 of the population) was observed in certain plots of curly-top-susceptible checks (Acc.1119 and 571002-0) when foliage readings were made. Otherwise, that disease was negligible in this test. Plants with obvious curly-top were disregarded in making readings.

TESTS UNDER CURLY-TOP EXPOSURE, JEROME, IDAHO, 1958
Strains Combining Leaf-spot and Curly-top Resistance

By Albert M. Murphy

S.L. NUMBER	STRAIN DESCRIPTION	PERCENT CURLY TOP Test A1/	Test B2/
701	601 aa X (720 to 730 stocks)	10	25
720	F_4 (US 201 X CT9)	7	11
721	US 201 X (US 201 X CT9)	36	36
722	b_2 to US 201	75	85
723	do.	64	78
724	do.	41	66
725	F_2 (US 201 X US 201B-20)	50	44
726	F_2 (US 201B-20 X US 201)	32	18
727	F_2 (US 201B-20 X US 201B-19)	25	31
728	F_2 (US 201B-20 X US 201B)	35	36
729	F_2 (US 104 X US 201B-20)	30	16
730	F_2 (US 104 X US 201B-20)	10	16
731	US 201B Jerome CT sel.	27	51
333	US 33		50
028	US 41	6	

1/ Test A was planted April 28 and percent curly-top was taken August 1
2/ Test B was planted May 22 and percent curly-top was taken September 2

PRELIMINARY YIELD TEST, TAYLORSVILLE, UTAH, 1958
Strains Combining Leaf-spot and Curly-top Resistance

By C. H. Smith

S.L. NUMBER	STRAIN DESCRIPTION	ACRE YIELD			PERCENT SUCROSE	CURLY-TOP INJURY
		GROSS SUGAR		TONS		
		Lbs.	% Basis	BEETS		8/22
701	601 aa X (720 to 730)	9801	109	35.6	14.0	none
720	F_4 (201 X CT9)	6413	71	28.4	11.3	none
721	201 X (201 X CT9)	6054	67	26.3	11.6	none
722	b_2 to 201	6069	68	21.5	14.2	Severe
723	do.	7685	86	29.9	12.7	Moderate
724	do.	6848	76	27.0	12.7	Slight
725	F_2 (201 X 201B-20)	8960	100	33.1	13.5	none
726	F_2 (201B-20 X 201)	7916	88	28.5	14.0	none
727	F_2 (201B-20 X 201B-19)	8550	95	30.5	14.0	none
728	F_2 (201B-20 X 201B)	8862	99	34.5	12.9	none
729	F_2 (104 X 201B-20)	9141	102	37.2	12.3	none
730	F_2 (104 X 201B-20)	9869	110	36.8	13.4	none
731	201B Jerome CT sels.	6837	77	24.4	14.0	Moderate
028	US 41	8971	100	35.6	12.6	none

Remarks: Plots consisted of two rows 22 ft. long. Three replications with US 41 as a check. Soil type was Taylorsville sandy loam in excellent state of fertility. In the test field, curly-top was very severe on susceptible varieties, but varieties with intermediate resistance (F_1 hybrids or US 33) showed only traces of curly-top symptoms. Many affected plants recovered from curly top in September. SL 722 was the only strain in this test which showed significant injury at harvest time. The test was planted April 17 and harvested October 2.